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ISOSTASY AND THE SIZE AND SHAPE OF THE EARTH[1]

IT is the speaker's desire, in this paper, to touch briefly on some phases of geodesy which should be of general interest to the physicist.

Geodesy is one of the oldest sciences; probably second in this respect to astronomy alone. What is the extent of the earth in the horizontal plane, to what depth does it extend, and what is on the other side are questions which must have been asked by men of the earliest times. The history of geodesy will have to be passed over, for lack of time, although it would be interesting to follow the accumulation of data as to the shape and size of the earth.

Before one can study efficiently the great geophysical facts and comprehend them, he must know the shape and size of the earth with considerable accuracy. For some time before the end of the seventeenth century, it was taken for granted that the earth was a true sphere.

The announcement by Newton in 1687 of his theory that the earth was an oblate spheroid added much interest to the subject of its exact shape.

A meridional arc of about 8½ degrees, extending north and south of Paris, was measured by J. and D. Cassini between the years 1683 and 1716. The results of the first computations of this arc indicated that the length of the degree was less at the northern than at the southern end. This gave to the earth the shape of a prolate spheroid. A great controversy arose over

[1] Read on December 30, 1913, before Section B of the American Association for the Advancement of Science, at Atlanta, Ga.

the question as to whether the earth has the form of an oblate or prolate spheroid, and to settle it the French Academy sent expeditions to Peru in 1735 and to Lapland the following year to measure arcs near the equator and within the arctic circle. The result of these measurements confirmed the theory of the oblate spheroid. A revision of the computations of the Paris arc also showed that the northern degrees were the longer, thus confirming the results obtained from the work done in Peru and Lapland.

The first near approach to the size of the earth resulted from triangulation done in the last decades of the eighteenth century to connect the observatories of Paris and Greenwich and to determine the length of the earth's meridian quadrant. For the latter purpose an arc of the meridian of nearly ten degrees was measured in France. One ten-millionth of the resulting length was adopted as the standard of length (the meter). Any other length could have been selected as the standard, for the meter bears no such exact relation to a quadrant as later and more accurate data show.

Geodesists were very active during the nineteenth century and will be for some time to come, in making geodetic measurements to determine the mean figure of the earth with greater and greater degrees of accuracy. There comes a time, for any one given area, when it is useless to add more geodetic data for the purpose of obtaining a more exact mean figure, for there are constant or systematic errors present in the data, the effect of which is probably much greater than that of the accidental errors.

But there is much to be gained by extending geodetic surveys to new areas and especially to new continents. (By geodetic survey is meant, here, triangulation and connected astronomic stations.) All of the values of the earth's figure now available are the results of geodetic measurements in the northern hemisphere and, with the exception of India, the measurements have been confined to Europe and the United States. We may hope to get, before long, values for the figure of the earth from geodetic operations in South America and Africa, most of whose areas are below the equator, and Australia, all of which is in the southern hemisphere. It is believed that the mean figures resulting from accurate and extensive geodetic data in those continents will agree closely with the figures gotten from continents in the northern hemisphere. The geodetic surveys of the several nations on each continent should be connected and the reductions made on one spheroid and referred to a single initial position for each continent. Should this be done we shall be able eventually to compute a mean figure of the earth which will be of such great precision that it will satisfy the most exacting demands of science. The same spheroid and datum have already been adopted by Mexico, Canada and the United States.[2]

Coincident with the extension of geodetic surveys there will be carried on the computation of the geoid or the actual surface of the earth. This surface is probably so complex in shape that the work necessary to define it will have to be continued long after the satisfactory spheroid has been determined.

The geoid may be defined as that surface which coincides with the surface of the sea at rest. We can imagine an extension into the continents of an intricate network of sea-level canals. Then the surface of the oceans and the water in the canals would define the surface of the geoid. At some

[2] See news note in *Bulletin of the American Geographical Society*, August, 1913, page 614, on "The Adoption of the North American Datum."

points, probably not exactly at the sea shore, the mean figure of the earth—the spheroid—would intersect the actual sea surface, the geoid. Under the coastal plains the geoid would be slightly above the spheroid; while under great mountain ranges the geoid would be far above the spheroid, possibly as much as one hundred meters. Over the oceans the geoid would be under the spheroid surface by amounts varying directly with the depths of the water.

There is only one way to determine accurately the size of the earth, and that is by measurement on the continents of the lengths of arcs connecting points where the astronomic latitude and longitude have been determined. The measurements of such arcs may be direct, or they may be by means of triangulation. The earliest measurements were by the former method, but with the introduction of accurately graduated circles and the application of wires in the eye-pieces of telescopes, the indirect method came into general use.

At frequent intervals, in triangulation, the sides of some of the triangles in the scheme are accurately measured, in order to control the lengths. At the present time, this is done almost exclusively with nickel-steel (invar) tapes or wires. The probable accidental error of a measured length is seldom greater than about one part in one million. The constant error in such a measurement may be as great as one part in three hundred thousand. This accuracy is, however, far greater than that of the lengths of the triangle sides, as computed through the chain of triangles. The uncertainty of any one line between bases is about one part in one hundred thousand, on an average. A long arc, say one across a continent, can be measured with greater accuracy than that, for even the systematic and constant errors of the various sections of the arc would probably act as accidental errors, and the greater portion of their effect would be eliminated.

The observations for latitude, longitude and azimuth, or direction, are made on the stars; and in the most refined work a correction is made for the variation of the pole.

One might think that the determination of the figure and size of the earth is a very simple process, consisting merely of obtaining by astronomic observations the accurate angular distances between each two of several points on a meridian, and then measuring accurately the linear distances between them. Three such points being sufficient to obtain the equation of the curve formed by the intersection of the meridional plane and the spheroid, the shape and size of the earth would be known. This would be true if the spheroid and the geoid coincided throughout, but, as stated above, they do not do so. The plumb line to which all astronomic observations are referred is, at each point, normal to the geoid, which is a very irregular surface and, therefore, very many astronomic stations must be established and used. The greater part of each of the differences between the astronomic positions, as actually observed, and the theoretical positions, based on an adopted smooth mean surface, must be treated as an accidental error. These differences reach a maximum value of about twenty-five seconds of arc (within the area of the United States) which is nearly one half mile. In the island of Porto Rico, the relative deflection between two astronomic stations, one at Ponce and the other at San Juan, was 56 seconds of arc, about one mile.

The shape, but not the size, of the earth may be determined from the observed value of gravity at stations widely distributed in latitude. But here again a few stations are

not sufficient, for the value of gravity does not follow any known definite law, owing to the disturbing influences of masses above sea level and the deficiency of mass in the oceans.

Helmert derived a formula in 1901 from the observed values of gravity at about 400 selected stations. This formula gives theoretical values which will agree well, on an average, with the observed values, but for any one station the difference may be large, even after one of the values has been corrected for the elevation of the station above sea level.

Helmert's formula, in the Potsdam system, is

$$\gamma_0 = 978.030\ (1 + 0.005302\ \sin^2\phi - 0.000007\ \sin^2 2\phi)$$

in which γ_0, expressed in dynes, is the theoretical value at sea level in latitude ϕ.

It is evident that the difference between the theoretical and the observed values of gravity, and the deflections of the plumb line (which, as stated above, are the differences between the observed and the theoretical astronomic positions) are due to the disturbing influence of the topography and the effect of deviations from the normal densities in the earth's crust. The term "topography" is applied to the visible land masses and the deficiency of mass in the oceans. But when the attractions of the topography are applied as corrections, the differences may still be large, but of the opposite sign.

About sixty years ago Archdeacon Pratt of England arrived at the conclusion, from a study of the deflections in India, that there must be a deficiency of mass under the Himalayan Mountains and that the deficiency extended to a limited depth. The advancement of this theory marked an epoch in geodesy. From time to time, writers in different countries have elaborated on the mere statement of Pratt. But it was Hayford who gave this theory a quantitative expression when, as a member of the United States Coast and Geodetic Survey, he corrected the astronomic latitudes, longitudes and azimuths in the United States for the effect of topography and its negative equivalent, called "isostatic compensation," when making two determinations of the figure of the earth.[3]

A preliminary report on the application of the theory of isostasy to the study of the deflections in the United States was made by Messrs. Tittmann and Hayford to the Fifteenth General Conference of the International Geodetic Association, held at Budapest, Austria-Hungary, in 1906.[4]

Isostasy was also considered by Hayford and the writer in reducing the gravity stations in the United States.[5]

In order that a clear idea of isostasy[6] may be obtained, I shall quote Hayford:

> If the earth were composed of homogeneous material, its figure of equilibrium, under the influence of gravitation and its own rotation, would be an ellipsoid of revolution.
>
> The earth is composed of heterogeneous material which varies considerably in density. If this heterogeneous material were so arranged that its density at any point depended simply on the depth of that point below the surface, or, more accurately, if all the material lying at each equipotential surface (rotation considered) were of one density, a state of equilibrium would exist and there

[3] "The Figure of the Earth and Isostasy from Measurements in the United States," by John F. Hayford, U. S. Coast and Geodetic Survey, 1909; "Supplementary Investigation in 1909 of the Figure of the Earth and Isostasy," by John F. Hayford, U. S. Coast and Geodetic Survey, 1910.

[4] "Geodetic Operations in the United States, 1903–06."

[5] "The Effect of Topography and Isostatic Compensation Upon the Intensity of Gravity," Spec. Pub. No. 10, U. S. Coast and Geodetic Survey, 1912, by John F. Hayford and William Bowie; same, second paper, by Wm. Bowie, 1912.

[6] The term *isostasy* was first proposed by E. C. Dutton. See *Transactions of the Philosophical Society of Washington, D. C.*, Vol. XI., pp. 51–64.

would be no tendency toward a rearrangement of masses.

If the heterogeneous material composing the earth were not arranged in this manner at the outset, the stresses produced by gravity would tend to bring about such an arrangement; but as the material is not a perfect fluid, as it possesses considerable viscosity, at least near the surface, the rearrangement will be imperfect. In the partial rearrangement some stresses will still remain, different portions of the same horizontal stratum may have somewhat different densities, and the actual surface of the earth will be a slight departure from the ellipsoid of revolution in the sense that above each region of deficient density there will be a bulge or bump on the ellipsoid, and above each region of excessive density there will be a hollow, relatively speaking. The bumps on this supposed earth will be the mountains, the plateaus, the continents; and the hollows will be the oceans. The excess of material represented by that portion of the continent which is above sea-level will be compensated for by a defect of density in the underlying material. The continents will be floated, so to speak, because they are composed of relatively light material; and, similarly, the floor of the ocean will, on this supposed earth, be depressed because it is composed of unusually dense material. This particular condition of approximate equilibrium has been given the name *isostasy*.

The adjustment of the material toward this condition, which is produced in nature by the stresses due to gravity, may be called the *isostatic adjustment*.

The compensation of the excess of matter at the surface (continents) by the defect of density below, and of surface defect of matter (oceans) by excess of density below, may be called the *isostatic compensation*.

Let the depth within which the isostatic compensation is complete be called the *depth of compensation*. At and below this depth the condition as to stress of any element of mass is isostatic; that is, any element of mass is subject to equal pressures from all directions as if it were a portion of a perfect fluid. Above this depth, on the other hand, each element of mass is subject in general to different pressures in different directions—to stresses which tend to distort and to move it.

In terms of masses, densities and volumes, the conditions above the depth of compensation may be expressed as follows: The mass in any prismatic column which has for its base a unit area of the horizontal surface which lies at the depth of compensation, for its edges vertical lines (lines of gravity) and for its upper limit the actual irregular surface of the earth (or the sea surface if the area in question is beneath the ocean) is the same as the mass in any other similar prismatic column having any other unit area of the same surface for its base. To make the illustration concrete, if the depth of compensation is 114 kilometers below sea level, any column extending down below sea level and having one square kilometer for its base has the same mass as any other such column. One such column, located under a mountainous region, may be three kilometers longer than another located under the sea coast. On the other hand, the solid portions of such a column under one of the deep parts of the ocean may be 5 kilometers shorter than the column at the coast. Yet, if isostatic compensation is complete at the depth of 114 kilometers, all three of these columns have the same mass. The water above the suboceanic column is understood to be included in this mass. The masses being equal and the lengths of the columns different, it follows that the mean density of the column beneath the mountainous region is three parts in 114 less than the mean density of the column under the sea coast. So, also, the mean density of the solid portion of the suboceanic column must be greater than the mean density of the sea-coast column, the excess being somewhat less than five parts in 114 on account of the sea water being virtually a part of the column.

This relation of the masses in various columns, and consequently of the densities, follows from the requirement of the definition of the expression "depth of compensation," that, at that depth, each element of mass is subject to equal pressure from all directions. In order that this may be true the vertical pressures, due to gravity, on the various units of area at that depth must be the same.

If this condition of equal pressure, that is of equal superimposed masses, is fully satisfied at a given depth the compensation is said to be complete at that depth. If there is a variation from equality of superimposed masses the differences may be taken as a measure of the degree of incompleteness of the compensation.

The investigations of the deflections and of gravity referred to seem to prove rather conclusively that in the United States a condition of isostasy exists. How perfect it may be, and what is the area of the cross-

section and the depth of the unit columns which are supposed to have equal masses, have not yet been accurately determined.

The depth of compensation is probably somewhere between one hundred and ten and one hundred and thirty kilometers.

It is reasonably certain that the compensation is not always complete nor always uniformly distributed to the depth of compensation. (The above statements are, of course, intended to apply only to the area of the United States. Later on a brief statement will be made in regard to the rather limited results obtained in the other countries.) But the average conditions in the United States indicate a close approximation to those postulated.

The application of isostasy reduced considerably the apparent anomalies, or deflections, in the United States and Hayford was able to compute a figure of the earth which is generally considered one of the best, and probably the very best, now existing. His dimensions[7] are:

Equatorial radius, 6,378,388 ± 18 meters.
Polar semi-diameter, 6,356,909 meters.
Reciprocal of flattening, 297.0 ± 0.5.

The application of isostasy to the reduction of the gravity observations has reduced the average anomaly in the United States to 0.018 dyne, and at only one station is the anomaly greater than 0.060 dyne. It is, therefore, now possible to compute a value for gravity at any point in this country with an uncertainty of 0.018 dyne. By either of the previous two generally used methods of reduction, in which isostasy was not employed, the average anomaly in the United States was much greater.[8] The largest free air anomaly was 0.216 dyne and there were five other anomalies with values greater than 0.100 dyne. There were five Bouguer anomalies greater than 0.200 dyne and twenty-eight other anomalies greater than 0.100 dyne. It was found from the anomalies developed by the investigations of deflections and of gravity that there was no apparent relation between the topography and the size and sign of the anomalies nor between the anomalies and the areas of erosion or deposition. Some relations to the geological formation were developed.[9]

A severe test of the new method of reduction of gravity observations, with isostasy considered, was the determination of the flattening of the earth, from the stations in the United States alone. The resulting value is 1/298.4. This value agrees almost exactly with Helmert's value of 1/298.3 which resulted from a consideration of gravity stations widely scattered over the earth and with a great range in latitude. The anomalies by each of the older methods of reduction, in which isostasy is ignored, gave values which differed greatly from the generally accepted best values.

A brief statement of the method of making the gravity observations and of the accuracy attained will suffice. All of the stations in the United States used in the recent investigations had gravity determined by means of the quarter-meter invariable pendulum[10] which makes an oscillation in approximately one half second. It is a modification of the pendulums devised by

[7] See p. 54, "Supplemental Investigation in 1909 of the Figure of the Earth and Isostasy."

[8] The average free air anomaly was 0.028 dyne and the average value of the Bouguer anomaly was 0.063 dyne.

[9] See pp. 18–21 of "Effect of Topography and Isostatic Compensation upon the Intensity of Gravity" (second paper).

[10] This pendulum and its case are described in App. 1, Report of the Superintendent of the Coast and Geodetic Survey for 1894, by G. R. Putnam. The method of obtaining the flexure of the case and the support is described in App. 6 of the Report for 1910, by W. H. Burger.

von Sterneck of Austria and first used by him about the year 1887.

The method employed is to determine the period of oscillation at a base station and then at the new station and from the relation between the two periods the difference in gravity between the two stations is determined. This is called the differential or relative method of determining gravity. The difference in gravity may be obtained with an accuracy represented by a possible error of about ± 0.0018 dyne, on an average.

The base station for the United States is at the office of the Coast and Geodetic Survey in Washington, D. C. The value for it was determined by the relative method, from the station at Potsdam, Germany, at which the absolute gravity had been determined from a long series of observations made with reversible pendulums.

It is difficult to determine the absolute gravity with a great precision, as is shown by the determination of the difference in gravity at Vienna and Potsdam, by the relative method. Each of these stations had its absolute value determined by many years of observations and each value was considered to be correct by an amount represented by a probable error of only a few thousandths of a dyne. The relative determination showed an error between them of 0.016 dyne.

Of course, the same constant error which may be present in the base station of a system will also be present at each station of that system determined by the relative method. Potsdam is now generally used as the base station for the world, although the values are also occasionally referred to the Vienna station. The values in the two systems will differ by 0.016 dyne.

A comparatively small error in the value of gravity at the base station of the system does not appreciably affect the flattening of the earth, derived from the gravity data of the system.

The investigations made in the Coast and Geodetic Survey show that, on an average, the gravity anomalies and the unaccounted for residuals of the deflections of the vertical are small for the United States. They also show that the area of the United States as a whole is practically in a state of perfect isostatic equilibrium. But there are many places where the gravity anomalies and the deflections indicate departures from the state of equilibrium. It is very important that additional data may be gotten which will permit of a determination of the degree of deviation from the perfect state and of the horizontal extent of the affected regions.

In one of the illustrations[11] of the second report on the gravity investigations, which shows by contours the Hayford anomalies, the evidence would lead one to believe that the causes of the largest anomalies are confined to small areas. For instance, there is an anomaly at Washington of $+0.037$ dyne, while at Baltimore, only 40 miles distant, the anomaly is -0.011 dyne. At Seattle, the anomaly is -0.093 dyne, while at Olympia it is $+0.033$ dyne, and the distance between the two places is only about 50 miles. There are other cases of decided differences in the anomalies in short distances, and no doubt more will develop when additional gravity stations have been established.

The data shown in the illustration referred to lead to the conclusion that there is no extensive area in the United States which is very much under or over compensated. This is equivalent to saying that

[11] No. 2 of the "Effect of Topography and Isostatic Compensation upon the Intensity of Gravity" (second paper).

there is no large area which departs much from the perfect isostatic state.

It has been held by some[12] that the crust of the earth within the area of the United States is at all places in a state of perfect isostasy and that the gravity anomalies are caused by the investigators' erroneous distribution of the compensating deficiency of mass. This, no doubt, is true to a certain extent, but no rational distribution will account for the larger anomalies except upon the theory that there are local actual departures from the perfect isostatic state.

Earlier in this paper it was stated that there were developed some relations between the size and sign of the gravity anomalies and the geological formation. The stations established on the oldest rocks show an average anomaly of + 0.024 dyne, that is they indicate too much mass in the earth's crust, while the most recent formations and the effusive and intrusive rocks give average negative anomalies which vary from —0.005 to —0.015 dyne. These show deficiencies of mass. It is not clear whether these anomalies are due to local deviations from the adopted mean surface density of the earth (2.67) or to actual departures from a state of complete isostasy.

The following table shows a summary of the gravity anomalies arranged in the several geological groups.

Geologic Formation	Number of Stations			Mean Anomaly	
	All	With plus Anomalies	With Minus Anomalies	With Regard to Sign	Without Regard to Sign
Archeozoic and Paleozoic	9	9	0	+0.024	0.024
Paleozoic	32	13	19	— .004	.019
Mesozoic	20	9	11	+ .001	.015
Cenozoic	33	15	17	— .007	.021
Effusive	8	2	6	— .005	.016
Intrusive	5	1	4	— .016	.018
Unclassified	16	10	6	+ .008	.020
All stations	123	59	63	— .001	.019

A stratum of material 100 feet in thickness, and of indefinite extent will cause an attraction of 0.0030 dyne. Therefore, the average anomaly 0.019 dyne would correspond to a stratum 630 feet in thickness. The average elevation of the United States is about 2,500 feet. Therefore, the isostatic compensation may be considered to be about 75 per cent. complete on an average for stations in this country. But the average gravity anomaly with regard to sign is 0.000 dyne, or nearly so, therefore it is safe to conclude that the area of the United States as a whole is in a state of perfect isostasy.

A more exact knowledge of the precise location with respect to depth of the compensating deficiency or excess of mass would be of very great interest and value. This is particularly true in the case of the areas where there are stations with large gravity anomalies. A preliminary study by the Survey will be made of this question in the near future. For this purpose the value of gravity and the deflections of the vertical in the vicinity of the anomalous areas will be used jointly. The preliminary studies may show whether much is to be expected from future investigations after much more gravity and deflection data are available.

An attempt will be made shortly to correct the deflections for the effect of the excesses and deficiencies of mass as shown by the gravity anomalies. It is possible that some of the unaccounted for portion of the deflections may be eliminated. The ideal condition would be to have only such residuals of the deflections as are caused by an error in the adopted figure of the earth, for then a new figure might be com-

[12] "Interpretation of Anomalies of Gravity," by Grove Karl Gilbert, Part C of Professional Paper 85, Contributions to General Geology, 1913, U. S. Geological Survey.

puted which would have far greater accuracy than any now existing.

The theory of isostasy has been applied in several other countries in the reduction of deflections and of gravity, but not to any great extent. In Switzerland the new method makes the observed and computed gravity agree more closely than do other methods which do not consider isostasy. In India the theory of isostasy has been applied and the preliminary results indicate that that country is not so completely compensated as is the United States.[13] The complete reductions have not been made. Their results will be of world-wide interest and importance.

The reduction, by the new method, of all the gravity stations of the world should be made in order that additional data may be available for studying the distribution of the materials in the earth's crust in different parts of the world, and because the results would make it possible to compute a better shape of the earth. There is no necessity for delaying this reduction. Mr. Tittmann, the superintendent of the Coast and Geodetic Survey, in his report to the conference, at Hamburg, in 1912, of the International Geodetic Association, stated:

> It is hoped that the International Geodetic Association in the near future may reduce all the available gravity stations of the world by this method, for it is reasonably certain that a value for the flattening of very great precision could be deduced from the results.

While each of the great nations and many of the smaller ones are making gravimetric surveys, yet there are many sections of the globe which have very few or no gravity stations. Some great institutions may, in the not distant future, see the importance of a world-wide gravimetric survey and start out parties to make one.

The geodesist is in great need to-day of an apparatus for measuring gravity accurately on a vessel at sea. We have no accurate values over the vast ocean areas. Dr. Hecker's gravity determinations at sea, with the boiling point thermometer apparatus, are subject to uncertainties as large as the largest new method anomalies of gravity in the United States, that is, between 0.050 dyne and 0.100 dyne. Gravity at sea should have actual errors not greater than about 0.010 dyne.

Some of the geological questions may or may not be answered by a consideration of isostasy,[14] but with isostasy an established fact, at least for large areas, the problems should not be as difficult as when various theories were held as to the degree of rigidity of the earth's crust.

One of the problems is as to the manner in which the earth's surface assumed an irregular shape. This is probably the most difficult one to answer. Of the theories proposed by a number of great men of science, none seems to be entirely satisfying. The theory of the unequal contraction of the outer layers of the earth during the change from the liquid to the solid state sounds reasonable until we consider that the thickness of the crust which could be affected is only about 70 miles, according to the theory of isostasy. There are extensive areas on land which average several miles in height. Also the great deeps in the oceans for considerable areas have average depths as great as four miles.

[13] In a letter from Col. Burrard, published in *Nature*, May 8, 1913, he makes the statement: "Both the pendulum and plumb-line observers find the attraction of the Himalayas to be largely compensated, whilst the Windhyan Mountains are not compensated at all." It should be noted that the Himalayan range is about 4 miles in height, and the Windhyan range only 0.6 mile in height.

[14] See "The Relations of Isostasy to Geodesy, Geophysics and Geology," by J. F. Hayford, SCIENCE, N. S., Vol. XXXIII., No. 841, pages 199–208, February 10, 1911.

It is impossible that the same materials could have densities differing by six parts in seventy, or nine per cent., due simply to unequal contraction from loss of heat. It is conceivable that the chemical elements of the earth's crust were the same everywhere before solidification, but they must have formed different chemical compounds in order to have had such different densities as must obtain in order to have the earth's crust in a state of equilibrium. The materials in the crust below the depth of 70 miles are assumed in the investigations to be in hydrostatic equilibrium and consequently they should have the same density in any layer at a given depth.

A theory, held by some, would make the depth of compensation a function of the elevation of the surface. The mountains would, according to this theory, have long roots of low density extending far down into the plastic materials, which are supposed to be below the seventy-mile depth. The investigations of the Coast and Geodetic Survey do not seem to substantiate this theory. If it were true we should have all of the crust under the continent of the same density down to a certain, unknown depth at which the plastic substrata began. The compensation would take place below that depth and it would consist in protuberances extending down into the plastic matter. The interior of the earth must be solid, but yielding to long-continued stress differences. Just how the depression of the sea bottoms is to be accounted for under this theory, the writer does not recall having heard. The crust there would probably have to be very thin.

A short article by Dr. P. G. Nutting,[15] suggested to the writer a possible cause of part of the elevation of the continents and the depression of the ocean beds. Let us assume that the surface of the earth, formerly at a high temperature, had cooled to a point below that of boiling water and that the surface was not level. Then the aqueous vapor would condense and fall in great quantities as rain and remain on the earth and flow to the lowest areas. This added mass would tend to produce an isostatic adjustment which would cause an undertow of material from the lower areas to the more elevated ones, with a resulting further depression of the low areas and elevation of the higher ones. How much effect this could have had is difficult or impossible to estimate. Of course, if there had been no irregularities in the earth's surface before the precipitation, the water would have covered the earth to a uniform depth.

The correct answer to another question would be of great value to several branches of science. The earth's crust, at least that part of it within the United States, may now be considered in a state of perfect isostatic equilibrium. But what was its condition in past geologic ages? It seems reasonable to suppose that the earth's crust was in the past in a state of isostatic equilibrium at least as perfect as at present, if it is assumed that the earth's crust is gradually getting cooler. With a high temperature the materials of the crust would have been more plastic than at present and should have yielded more readily to stress differences.

If we have now and always have had a condition of equilibrium in the earth's crust, can the recorded movements be explained on the isostatic theory?

The deflections and the pendulum observations show that the areas from which great masses of materials have been eroded are in equilibrium; also that areas within

[15] "Isostasy, Oceanic Precipitation and the Formation of Mountain Systems," SCIENCE, October 6, 1911.

which there have been great depositions are in isostatic equilibrium. We, therefore, must conclude that the mountains have been maintained for long ages at approximately the same elevation by an undertow of material toward them, while the areas of deposition maintain their depth in spite of the added material by a sinking due to the undertow from the crust under such areas. Consequently, the continent may be considered as not being leveled off as a result of erosion, but as kept at approximately the same general elevation.

While an isostatic adjustment by means of a transposition of material may account for the normal condition under the areas of erosion and deposition, it does not account for the great elevation, into mountains and plateaus, of rock which was once under the ocean. Evidently there must have been a change in the density, under such areas, and an expansion of the materials in the earth's crust to the extent indicated by the height of the topography above the sea. This change was not due to a mere expansion from change of temperature, as a bar would expand. The expansion of the crust must have been due to chemical or physical changes which made the elements present form compounds with densities differing from what they had been previously. What could cause such rearrangement as to change the density by several parts in one hundred is a problem for the geophysicist and geologist.

The fact that material which was once under the sea now forms a mountain range seems to disprove the "root of the mountain" theory of compensation. It is difficult or impossible to see how the crust with its surface at or below sea level (supposedly in isostatic equilibrium) could, in addition to expanding to form the mountains, also decrease its density in that portion far below the average depth of compensation (122 kilometers). As a matter of fact, the deflections and the gravity observations indicate that the compensation is not deep down in the crust, but in general within the depth stated above.

The movements noted in the exposed earth's materials have been slow and were in most cases due to stress differences which were below the rupturing point of the rock. There has been much slow yielding, without fracture, to long-continued stress differences. The isostatic adjustment of the earth's materials in the upper crust after or during erosion might cause many of the movements that have been recorded in the strata.

In conclusion, the immediate work which the geodesists should perform is to reduce all the existing gravity stations of the world by the same method which should be based on a rational theory of isostasy. As opportunity permits, a gravimetric survey should be extended to new regions and especially to oceanic islands. And as soon as an apparatus is designed which may be used successfully on a vessel, an extensive gravimetric survey of the oceans should follow.

WILLIAM BOWIE
U. S. COAST AND GEODETIC SURVEY

SAFEGUARDING THE HEALTH OF COLLEGE STUDENTS[1]

ATTENTION has frequently been called to the fact that many educational institutions fail to make adequate provision for safeguarding the health of their students. These criticisms find expression most often in connection with the report of the injury or death of a student who has been allowed to participate in athletics without proper medical supervision; or when some serious sanitary fault causes, or contributes to, an epidemic among the stu-

[1] Based upon paper presented at Fourth International Congress on School of Hygiene, Buffalo, 1913.

dents; or there is unfavorable comment when some promising young student breaks down in course or shortly after graduation as a result of overwork or bad hygienic habits.

Many cases even more deserving of unfavorable criticism in which the student suffers avoidable physical damage and loss of time and money never come to light. These may be due to physical tendencies and handicaps that should have been discovered and warned against on examination, or to sicknesses that could have been avoided by better sanitation and control of living conditions. Four years of life in a college or university should mean for the average boy or girl a distinct gain in physical efficiency and in habits of sane, hygienic living instead of the opposite of these things, as is too often the case.

It is of course true that to-day nearly every institution of college rank is trying to make, or intends to make, some provision for protecting and promoting the health of its students. There has been a very marked change for the better in this respect during the past few years, and a wider recognition of the practical importance of measures that tend to keep the student in good health. Too often, however, the provision made consists merely of a gymnasium and facilities for competitive athletics, the use of which as well as the time and energy of the teachers are mainly limited to that small percentage of the student body who are candidates for the teams; and in connection with which there is no well-considered plan for bringing these and other agencies in the institution into a harmonious relationship for effective work in promoting health and efficiency.

It is not probable that any system of health supervision, however carefully devised and administered, can entirely prevent the occurrence of sickness or accident among the students. There can be no question, however, that much more should be done than is being done or even considered, in the majority of colleges and universities in the country, to limit the amount of preventable sickness and to increase the working efficiency of the students; nor can there be any question of the real and permanent value of such preventive and educational work for both the individual and the community of which he becomes a part. The formulation of an adequate plan for health supervision must be based upon a consideration of the factors affecting student health in the college community. Such a study will suggest the division of these factors into two groups. In the first group will fall those factors that may be classed as "environmental," *e. g.*,

1. General sanitary condition of the neighborhood such as drainage, sewage disposal, breeding places for flies and mosquitoes.

2. Food and water supply in commons and boarding houses.

3. Sanitary conditions of rooms in dormitories and lodging houses as regards baths, toilets, janitor service and general surroundings.

4. Provision for advice and treatment in dispensary or infirmary in case of sickness.

5. Opportunities for exercise and recreation.

The second group will include the "individual factors," such as:

1. Physical characteristics and tendencies to weakness.

2. Knowledge and practise of the essentials of personal hygiene.

3. Habits of exercise and recreation.

This grouping serves at Princeton University as a logical basis for the division of responsibility for the supervision of student health between two closely allied bodies: The sanitary committee and the department of hygiene and physical education.

The sanitary committee is composed of six men appointed from the board of trustees and the university faculty, one of whom is a member of the department of hygiene and physical education. It has the responsibility for the administration of those factors which I have called "environmental." It maintains a close supervision over the administration of the commons and the infirmary; it employs the university physician, and has periodical inspections made of those lodging and boarding houses used by students for whom—about 15 per cent.—there is at present no provision on

the campus. It is also advisory to the board of trustees on such questions as:

1. Plans for modern sewage disposal plant.
2. The installation of a milk-pasteurizing plant in the commons.
3. Plans for a new infirmary, and a study of the sanitary features of plans for new buildings.

The administration of the second group of factors, those relating to the individual himself, falls to the department of hygiene and physical education. This department is organized and equipped to fulfill the following functions:

1. To conduct a regular academic course in hygiene, which is required of all freshmen one hour a week throughout the year.
2. To make thorough medical examination of all freshman at the beginning and the end of the year, and of all candidates for competitive teams at the beginning of each season, or more frequently in special cases.
3. To conduct classes in physical education, which is required of all freshmen three periods a week throughout the year.
4. To provide opportunities for exercise and the necessary instructions in voluntary work by upper classmen.
5. To encourage participation in intramural games and competitions by those who are not candidates for the regular university teams.
6. To stimulate the development of habits of hygienic living and of outdoor exercise and recreation among the whole student body.

Since the health interests of the university are closely bound up with those of the town, a natural and harmonious relationship has grown up between these two parts of the community for the promotion of the interests of general health. The active bodies in this work are the university sanitary committee and the borough board of health with its health officer. This board is composed of seven men, three of whom are members of the university. The president of the board is also chairman of the university sanitary committee, thus providing an opportunity for the closest cooperation between the two bodies. The effectiveness of this relationship is shown in the measures that are put in force by joint action to improve the sanitary conditions in the community at commencement time, when there are many reunion headquarters temporarily established throughout the town; and at the time of the big games when there is an influx of from 20,000 to 30,000 people with the consequent strain upon sanitary provisions. The university contributes towards the salary of the health officer, so his services are available, under the direction of the sanitary committee, for the inspection of boarding and lodging houses occupied by students; for the periodical examination of the milk supplied to the commons and of the water in the university swimming pool; and for the technical supervision of the sanitary condition of grounds and buildings. The close relationship existing among these three bodies, the board of health, the sanitary committee, and the department of hygiene, makes possible an effective cooperation which results in an economical and efficient administration of the health problems of the entire community.

A university in a small town like Princeton which has a population aside from the university community of about 5,000 presents a simple problem from the point of view of health protection as compared with an institution located in a large city. It may be impossible to work out such an organization as this that we have been considering in every college town; but the general principle of establishing some comprehensive and effective plan of health administration should be put into effect in every large institution. A brief discussion of some of the essential phases of the plan as outlined may be of use in giving a clearer view of the work.

The supervision of the Princeton University infirmary is a function of the sanitary committee. The infirmary is in charge of an infirmarian, who is assisted by the necessary nursing and housekeeping force. The building contains fifteen beds and was built nearly twenty years ago. An isolation ward of about the same size was added later. A well-equipped dispensary adds greatly to the usefulness of the infirmary. Plans for a new in-

firmary are practically completed, as the present building is sometimes taxed to its utmost. The university physician is employed by the sanitary committee and attends the infirmary three hours daily, during the early morning and the late afternoon. Students are admitted upon his certificate and attended by him. A student may be attended by a physician from the town who is approved by the sanitary committee; and physicians and surgeons may be called in consultation if necessary.

Students are charged $7 a year infirmary fees, which cover all necessary expenses during their stay in the infirmary. In contagious cases, or cases requiring special nursing the expense of the additional nurse is charged to the student. As board bills are charged to all students on their regular term bills the infirmary is credited with the amount of board the student would ordinarily pay during such time he may be confined to the infirmary. During the past year there were 400 bed cases, and about 4,500 dispensary calls. These figures may seem large for a student body of only 1,500, but much of the service in the dispensary, and even among the bed cases is in a measure preventive. For example, a boy with an incipient cold may be put to bed over Saturday and Sunday, and so a more serious illness and a further loss of time prevented.

In case a student is confined to his room by sickness that fact is reported to the college office before 10:30 by the janitor or the lodging house mistress, together with a statement whether or not a physician has been called. This early report gives an opportunity for word to be sent to the university physician, so that he can visit the student before noon if he has not secured medical attendance. No sick student is allowed to remain in his room in a dormitory more than a day. He is promptly taken to the infirmary, where he is given medical attention and nurses' care.

The inspection of the lodging and boarding houses is done regularly and a report is made on a form provided for the purpose. The points investigated include among others a statement as to the kind of house, the kind of room, the provisions for heating, lighting and ventilation, the bath-room provisions, and the general character and tone of the place and people. In the case of boarding houses additional information is gained regarding the sanitary conditions of the dining-room, the kitchen, the refrigerator, care in garbage disposal, and notes on the general surroundings, such as the proximity of stables, chicken yards, exposed garbage, etc. Repeated inspections are made at irregular intervals during the year. Any defects are reported to the secretary of the sanitary committee who serves notice upon the owners of the premises. If the recommendations are not complied with promptly, the students are ordered out of the premises. The knowledge that such action will be taken by the university authorities and the fact that all payments for board and rent are made through the university treasurer's office, have had the effect of forcing the owners to keep the premises in proper condition.

A comprehensive physical examination is conducted by the department of hygiene and physical education. Special emphasis is laid upon the determination of the functional condition of the eyes, ears, nose, throat and the vital organs. The information so obtained serves as a basis for advice as to special exercises if needed. Advantage is taken of the opportunity to discuss with each individual the various practises and habits that affect his mental and physical efficiency. A follow-up scheme has been devised which makes it possible to keep in touch with special cases at regular intervals during the year and to cases referred to the home physician.

The course in personal hygiene deals with the fundamentals of health and physical efficiency; the influence of diet, exercise, bathing, etc.; the effects of personal habits, as the use of tobacco and alcohol; sex hygiene; and a study of the more common infectious diseases, their nature, cause, methods of transmission and prevention. Emphasis is laid upon the practical points of daily life, upon inducing the students to adopt a hygienic method of living, and upon the fact that health is in a very large measure subject to control.

A good deal of emphasis is placed upon the effort to promote the formation of habits of outdoor exercise and recreation among the upper classmen. This is done by organizing classes for voluntary work in various branches of physical education and by encouraging the organization of teams for athletic competition. In the development of these intra-mural athletic activities, advantage is taken of every natural student division as a basis for the organization of teams, with the result that there were during the past year 145 organized teams playing regular schedules for the championships of various groups; and throughout the year there were more than 1,300 men, counting the duplications on various teams during the different seasons, and not counting those who were on the various varsity squads, who took part in these contests. Competitions were conducted in swimming, water polo, relay racing, rowing, basket ball and baseball. The above statement does not include the large number of students who take part in individual contests in boxing, wrestling, tennis, golf and swimming.

This plan of guarding and promoting student health has been developed under the stimulus of the conviction that an educational institution has a real responsibility for the physical welfare of its students; that health is an educational factor of prime importance; that a student not entirely well is working under a handicap and is lowering the efficiency of the institution; and that a healthy body is one of the first essentials of clear thinking, clean living and efficient citizenship.

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THE GOVERNMENT OF LEARNED SOCIETIES

IN connection with the work of a committee of the American Psychological Association I wrote a year ago to the secretaries of all the "learned societies" listed in the World Almanac asking how their officers were elected and whether the method was satisfactory. With very great courtesy almost every secretary answered my first question (though one or two copies of constitutions failed to reach me), and most of them answered the second. The result is that I find myself with an amount of material which it seems well worth while to put together in print.

The sixty-eight "learned societies" here listed can be divided according to their method of electing officers into some nine groups, as follows.

Group A.—In the following associations officers are elected by the governing board.

American Academy of Political and Social Science. Officers are elected by (9) directors, one third of whom are elected annually to serve three years.

American Antiquarian Society.

American Association for the Advancement of Science. Officers are elected from fellows by general committee, which consists of council plus one fellow or member elected by each section. Council consists of certain present and past officers, fellows elected by sections and affiliated societies, and nine fellows elected by the council. Permanent secretary, secretaries of sections and treasurer hold office for five years.

Archæological Institute of America. Officers are elected by council, which is composed of general officers and delegates from local affiliated societies. Executive committee is partly ex-officio, partly elected by council at annual meeting.

American Numismatic Society. Council elects officers. Members of council are nominated from the floor and elected by ballot.

National Association for the Study and Prevention of Tuberculosis. Officers are elected annually by board of sixty directors on nomination of committee appointed by chair. One fifth of directors are elected at each annual meeting.

National Geographic Society. Managers elect officers. Eight of the twenty-four managers are elected at each annual meeting to serve three years. A majority of the votes cast is necessary for election.

New York Zoological Society. Officers and executive committee are elected by managers. Executive committee appoints a nominating

committee which prepares and posts nominations to replace the outgoing class of board of managers. Members vote on these at annual meeting.

Group B.—In the following associations nominations for office are made by the governing board at the annual meeting. Usually the rule permits other nominations to be made from the floor, though they are not often made. It is not always clear whether or not the official nominations include positions on the governing board itself.

American Association of Obstetricians and Gynecologists.

American Association of Pathologists and Bacteriologists. Rule includes all nominations. Council member serves seven years.

American Bar Association. Officers nominated by general council, which consists of one member from each state.

American Geographical Society of New York. Rule includes all nominations, but nine or more fellows can also nominate.

American Ophthalmological Society.

American Pediatric Society.

American Proctologic Society.

American Psychological Association. Rule includes nominations for council.

American Therapeutic Society.

Society of Chemical Industry, New York Section. Committee nominates chairman, secretary and treasurer. Ten or more members can nominate ordinary member of committee. If there are not enough nominations committee completes list and there is no election. Five members of committee retire annually, three of whom shall be those who have made the fewest attendances at committee meetings.

Southern Medical Association.

The advantages claimed for this method of close control by the governing board are that it is less dangerous than off-hand nominations from the floor, facilitates business, has worked perfectly, allows meetings to be devoted to science exclusively. Eight secretaries commented on it favorably. In a ninth association a considerable number of members felt that it was unnecessarily oligarchical. Another objection is that it has occasionally been embarrassing to have a small governing body called upon to choose between two or more of its own members for the presidency. This objection would not hold in the case of an association whose governing board is composed largely of ex-presidents.

Group C.—In the three following associations nominations for office are made by a nominating committee which is itself a more or less permanent body. The election takes place at annual meeting.

American Gynecological Society. Nominating committee consists of all ex-presidents at meeting. Two nominations are made for each office.

Society for the Promotion of Engineering Education. Nominating committee consists of the past presidents and the seven elective members of the council retiring the following year, but the president may add enough to bring members present up to five.

American Philological Association. Each year the chair nominates one new member of the nominating committee to serve five years.

It is claimed on behalf of this method that it ensures continuity and causes less unfavorable comment than random nominations from the floor.

D.—In the American Society of Civil Engineers the membership is divided into seven geographical districts, each of which is represented by two members of the nominating committee, one elected each year to serve two years, and the five latest past presidents who are alive. The secretary is appointed by the board. The method appears to be satisfactory, though it is possible under it for men to be elected to the nominating committee who are not familiar with the work of the association.

Group E.—In the following associations a nominating committee is appointed annually by the governing body. Elections are at annual meeting.

American Historical Association. It is said that years ago this association tried and abandoned something like a preferential primary.

American Library Association. Nominating committee appointed by executive board from persons not on board. Board adopts report

and prints names on the official ballot. Others may be added on petition, with consent of nominee. Council is partly self-perpetuating.

Group F.—In the following associations a nominating committee is appointed annually by the chair, though in the cases indicated it is simply said that it is "appointed." The committee reports, and officers are elected at the meeting.

American Academy of Medicine. "Appointed."

American Association of Anatomists. "Appointed." Officers elected for two years, secretary for four. Executive committee of eleven.

American Climatological Association. Usually consists of ex-presidents.

American Dialect Society. Nominating committee is "appointed" at the annual meeting, receives suggestions as to who is willing to serve, and reports in a few minutes.

American Economic Association. "Appointed." Usually consists of ex-presidents if enough are present.

American Fisheries Society.

American Forestry Association. "Appointed."

American-Irish Historical Society.

American-Jewish Historical Society.

American Laryngological Association.

American Laryngological, Rhinological and Otological Society.

American Medico-Psychological Association.

American Oriental Society.

American Otological Society. Nominations by business committee of three appointed by president for that meeting.

American Roentgen Ray Society. "Nominees are then voted upon by the Society" (two tickets?). It has been recently arranged in the interest of democracy that the new member of the executive committee be elected by ballot.

American Society of Naturalists.

American Sociological Society. Executive committee is partly elected, partly made up of former presidents. Practise has been to keep the same group of officers for a period of two years.

American Statistical Association.

American Surgical Association.

The secretaries of every one of these nineteen associations commented on their method of electing officers. One of them said no fault had ever been found with the method, though ambitious people were sometimes disappointed in the results. A second said that for twenty years the method had been found satisfactory, but that during the last year it had been claimed that such nominations may reflect the views of an extremely limited portion of the association instead of voicing the general desire. The remaining seventeen said without qualification that it worked well: "the ticket is always elected," "the secretary casts a ballot and there is never a grumble." The following statement, however, may not seem very satisfactory to extreme democrats: "The association is usually very harmonious at its annual meetings, and a small group of people have for some years practically prepared the slate. I think this is practically the custom with all similar organizations, and I believe it rarely happens that there is any controversy in regard to the matter."

Group G.—In the four following associations the nominating committee is chosen more democratically. Officers are elected at annual meeting.

In the American Microscopical Society and in the American Orthopedic Association the nominating committee is elected at a business meeting.

In the American Urological Association members of the nominating committee are selected by and from the various members of the several Sections present at the annual meeting.

In the Medical Association of the Southwest the nominating committee is composed of five members from each of the five states composing the association.

All four of these associations seem to be satisfied with their methods.

Group H.—In the following associations officers are elected by members present at the annual meeting, but there appears to be no nominating committee.

In the National Academy of Sciences officers

are elected by vote of the members present at the annual meeting. There is nothing in the constitution about their nomination.

In the American Dermatological Association officers are nominated on the first day of the annual meeting and elected on the second.

In the American Institute of Architects officers are elected by ballot of the delegates at the annual convention.

In the American Medical Association nominations are from the floor. Majority of votes cast is necessary for election.

In the American Entomological Society officers are nominated at the meeting before the annual meeting. The nominations are not restricted in any way and there is no nominating committee.

In the Actuarial Society of America officers are elected at the annual meeting without any nominations being made. Previous to the meeting, however, there is a straw ballot for members of the council, every fellow voting for two candidates for each vacancy. The result of this straw ballot is announced before the election, but it does not bind anybody.

In the American Ornithologists' Union an informal ballot is taken at the annual meeting and its result is announced before the first formal ballot is taken.

In the American Institute of Homeopathy any ten members at annual meeting can nominate. If no one gets a majority at first election there is a second vote confined to two highest candidates. It has been ruled that members nominated for an office can not withdraw their names.

In the American Association of Public Accountants officers are elected by delegates and fellows at large at the annual convention. Secretary is elected annually by trustees.

In the American Philosophical Society held at Philadelphia for Promoting Useful Knowledge officers are elected on the first Friday of January and the polls are open between the hours of two and five in the afternoon. Nominations must be made at the stated meeting next previous to the day of election; but if there should occur a failure of qualified candidates so nominated others not so nominated may be elected.

Group I.—In all the following associations the business of nominating and electing officers is conducted largely through the mails.

In the Geological Society of America the council prepares the regular ticket, and this is mailed to the members at least nine months before the annual meeting. Any five members may forward other nominations to the secretary. Such nominations are printed together with the names of the nominators as special tickets. The regular and special tickets are then mailed to the fellows at least twenty-five days in advance of the annual meeting. Balloting is then done by the use of two envelopes, of which one, the inner envelope, bears a legend indicating that it is a ballot; the outer envelope bears the voter's name, and before it is opened the secretary looks up the records to see whether the man is entitled to vote or not.

In the American Mathematical Society the council nominates at the October meeting through a committee usually composed of ex-presidents and ex-vice-presidents. Nominations are printed on a ballot with blank spaces for other names, and mailed to members, who may vote by mail or in person at the December meeting.

In the American Nature Study Society the council nominates one or more candidates for each office and members vote by mail or in person.

In the American Public Health Association the council nominates officers and submits ticket to the whole association for their vote. Council represents different states and federal departments.

In the American Society of Mechanical Engineers the president appoints a nominating committee, and any group of twenty or more members entitled to vote may constitute themselves a special nominating committee. Names of nominees and their nominators are mailed to members on an official ballot, together with an inner and an outer envelope, as with the geologists. A simple plurality of votes elects. Method is said to be perfectly satisfactory.

In the American Institute of Electrical Engineers the method pursued up to 1911 was as follows. Nominating blanks were mailed to the entire membership. After the forms

were returned and canvassed the directors prepared a "directors' ticket." This ticket, together with a statement of the votes received by all the candidates who had received not less than 3 per cent. of the entire number of votes cast, was issued to the membership. Members could vote for any one whose name appeared on this blank. The directors' ticket was always elected, as the vote against any one upon it would be scattering. For geographical considerations the directors did not always select the candidates who had received the largest number of nomination votes. The principal objections to this method appear in the *Proceedings* for January, 1912. They are these. There is no official way by which a group of members who desire to recommend a certain candidate can make their wishes known to the entire membership. Members can not usually tell whether a man they think of nominating is willing to accept. The scattering vote is increasing each year. The only way to suggest candidates is by circular letters, which become a nuisance. Not more than 20 per cent. of the members fill out nomination forms; so that a man with a very small vote can get on the directors' ticket and be elected. The new rule provides that on petition of fifty members a man's name may be printed on the nominating blank as a candidate for nomination. This results in a larger and more concentrated vote.

In 1912 the American Institute of Mining Engineers was practically changing its entire management. Under the old rule there was a board of directors and a council. Nominations for members of the council could be sent to the secretary, who mailed to the members a list of all nominations for each office so received, together with the names of persons ineligible for election to each office; and if the council or a committee thereof should have recommended any nomination, such recommendation was sent also. The new method recommended by a special committee resembles that of the American Society of Civil Engineers.

In the American Chemical Society members mail preference for president and four councilors. Council elects president from the four having the largest number of nominating ballots. For council the highest eight are considered nominated, and names mailed to members. Usual double envelopes for secrecy. Nine directors are elected by letter ballot of the entire (102) council. The directors are now the governing body, as council has grown too large.

In the Astronomical and Astrophysical Society of America members were nominated by mail and the three with the largest number of nominating votes were voted upon by members present at annual meeting. In case of a plurality of names in third place all were included in list to be voted upon. Plurality elected. The method had not proved entirely satisfactory, and a committee had been appointed to consider its revision.

In the Botanical Society of America individual members nominate by mail. The council then sees that there is at least one nomination for every office. Members vote by mail. Plurality elects. A recent rule empowers the secretary to eliminate the names of all nominees but the three receiving the highest number of nominating votes. Yet sometimes ten or a dozen receive the same number and have to appear on the final ballot mailed to members. Another possible objection to this method is that a few members of the association in one of the large universities can easily put a set of names in nomination by concentrating upon them when other nominating votes are scattered.

The conclusions which I am disposed to draw from the material at my disposal are as follows: A governing board of some kind is indispensable, and it is wise to follow the usual practise of electing a given proportion of its members every year for a term of years. If there is much work to be done by the secretary, he should be nominated either by a permanent nominating committee or by the governing board. If he accepts remuneration for his services he should be nominated or appointed by the board.

It is not usually wise to try to elect members of the governing board or other officers

without the aid of the board or some other committee, and it is distinctly unwise to do so if nominations are made through the mails.

If the board or a special committee is to act at all on nominations it seems better for it to nominate in the first place than to act on haphazard nominations afterwards. If the board itself nominates there is no reason why it should not send ample notice of its ticket to all the members of the association. In the absence of such notice it is not usually desirable that the board should nominate its own future members; for reasonable continuity in the management of an association is sufficiently insured by changing only a part of the board at a time, and the action of a series of nominating committees appointed from year to year by retiring presidents is less likely to cause continued irritation to a section of the association than the corresponding action of a practically self-perpetuating board.

If an official slate is unsatisfactory there is more chance to break it under a rule allowing other nominations to be made by groups of a certain size than under one allowing them to be made by single individuals.

No plan of election by members present at the annual meeting has been shown to be better than the common one of allowing the retiring president to appoint a nominating committee.

If an association exists for the sake of its meetings and does not attempt in any way to regulate the practise of a profession, it is questionable how far its machinery should be complicated for the sake of giving those who do not attend the meetings a voice in its management.

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STANFORD UNIVERSITY

The trustees of Stanford University have increased the president's budget for the academic year of 1914–15 by approximately $75,000 over that of the present year, which was about $475,000. Of the increase, $33,370 is for additions to the salaries of the present members of the faculty, and $20,000 for an addition to the usual allotment for departmental equipment. Ten thousand dollars of the increase to the budget is for the maintenance of the university's memorial church, which upon the completion of rebuilding since the earthquake has been placed under the president's direction. The salary increases have been apportioned among the ranks in the teaching force as follows: professors, $11,950; associate professors, $6,350; assistant professors, $10,700; instructors, $4,370. The trustees also announce a number of new buildings to be added to the university plant. These include, for the medical school in San Francisco, the remodeling of the main hospital building and the addition immediately of a new wing practically doubling the capacity of that building, and later the erection of a new women's building; and on the campus at Palo Alto a new library building, a new gymnasium for men and a new museum building. The library building, preliminary plans for which are being drawn, based upon suggestions by Librarian G. T. Clark, who has recently visited new college libraries in various parts of the country, will with the new museum form the front of a new quadrangle approximately of the same size as the present main quadrangle of the university, which is not quite 900 feet long, and will lie just east of it. The museum will not be undertaken for two or three years. The present museum is about a quarter of a mile from the main quadrangle, and President Branner in his inaugural address, urging the educational value of beauty, declared that the art collections here are practically inaccessible to the average student. In this same connection, and following the president's suggestion in the same address, the trustees are working out a comprehensive scheme of landscape gardening for the beautification of the university grounds. The salary and equipment increases and the new building announcements are in fulfilment of a statement published a year ago by the Stanford trustees, in which they declared that the resources of the university will in the future justify an increase in the annual allotment for academic

purposes, and that with the collaboration of Chancellor Jordan and President Branner, they had determined to build up the present departments of university work to the highest point of efficiency before entering new fields. The salary increases, it is announced, are the first of several to be made with the intention of raising the pay of the teaching force to a level somewhat nearer than it has been to that reached by the cost of living.

FOREIGN STUDENTS AT AMERICAN COLLEGES AND UNIVERSITIES

THERE were 4,222 foreign students in attendance at colleges and universities in the United States in the year 1913, according to figures just compiled at the United States Bureau of Education. This is an increase of 577 in two years. These students are not concentrated at the larger and better known institutions, as might be expected, but are distributed over 275 different colleges, universities and schools of technology. The number given includes only regular students of college or graduate grade; if students enrolled in preparatory departments, short-term courses, summer schools and independent professional schools were included, the total would be very much larger.

Canada has the largest representation—653 students. China and Japan are not far behind—there were 594 Chinese students and 336 from Japan attending colleges in the United States in 1913. Of the other Oriental or Asiatic peoples, India is represented by 162 students; Turkey by 143; Korea by 13; Persia by 21, and Siam by 13.

Latin-America is strongly represented. Cuba sends 209; Costa Rica, 29; Guatemala, 15; Honduras, 12; Nicaragua, 18; Panama, 28, and Salvador, 19. Mexico heads the list with 223 students. From South America, Argentine sends 43 students; Brazil, 113; Bolivia, 3; Chile, 12; Colombia, 37; Ecuador, 16; Paraguay, 2; Peru, 25; Uruguay, 2, and Venezuela, 7.

Abundance of higher education opportunities in the British Isles and on the continent of Europe has not prevented nearly 800 European students from coming to America to go to college. Great Britain and Ireland are represented by 212 students, and Germany, herself the meca of the studious, sends 122. The others, in order of numbers, are: Russia, 124; France, 45; Sweden, 41; Italy, 38; Austria-Hungary, 34; Switzerland, 29; Norway, 26; Greece, 22; Spain, 20; Netherlands, 19; Bulgaria, 15; Roumania, 6; Belgium, 4; Portugal, 3; Montenegro, 1.

Even Australia and Africa have students at colleges in the United States. There are 56 students from New Zealand. Africa is represented by 15 from Egypt; 2 from Liberia, and 44 from South Africa.

From American possessions 434 students came to college in the United States; 108 from Hawaii; 215 from Porto Rico, and 111 from the Philippine Islands.

THE GEORGE WASHINGTON MEMORIAL

THE jury of award of the George Washington Memorial Association have given first honors to the architectural firm of Tracy and Swartwout, New York.

The members of the committee, Mr. Philip Sawyer, Mr. Charles A. Platt and Mr. Walter Cook, met for the consideration of the award, on May 2, but deferred their decision until May 4 when they came to the conclusion that of the thirteen competing architects, the plans rendered by Messrs. Tracy and Swartwout were the most satisfactory. The selected drawings will now be presented to the National Commission of Fine Arts, and, with their approval, the association will give the architects charge of the construction of the building. The first award is $1,500, but each competing architect who has submitted plans in accordance with the specifications will receive an honorarium of $500.

Tracy and Swartwout's drawings depict a fine colonial building with pillared front, and square ground plan. The main feature is the great auditorium seating 6,000 people, which is artistically arranged in the form of an ellipse, with the stage at one end, and a deep balcony encircling the whole. The site of the building is to be in that part of the

Washington Mall known as Armory Square. All the drawings entered in the competition are now on exhibition in the National Museum.

This building, to be known as the George Washington Memorial, and to be administered by the regents of the Smithsonian Institution, was authorized by an Act of Congress passed March 4, 1913. The work of construction must be begun before the fourth of March, 1915, or the authorization by congress for the use of the above site will lapse. It is further provided that the work of construction can not be commenced until the sum of $1,000,000 is raised by the association, and although Mrs. Henry F. Dimock, president of the association, and chairman of the building committee, has secured a good part of this sum, much still remains to be raised.

SCIENTIFIC NOTES AND NEWS

The Willard Gibbs medal will be presented by the Chicago section of the American Chemical Society to Dr. Ira Remsen on the evening of May 15.

Former students of Professor John Henry Comstock have raised a fund, to be known as the Comstock Memorial Library Fund, which is to be presented to Cornell University for a permanent memorial of Professor Comstock's forty years of distinguished service as instructor and professor of entomology. He is to retire from active teaching as a member of the faculty next June, at the age of sixty-five. The ceremony of presentation will take place on June 13.

The Academy of Natural Sciences of Philadelphia has elected as correspondents the following: Frank M. Chapman, Edmund Heller, Edgar A. Mearns, Gerrit S. Miller, Charles W. Richmond, Marie Curie, Shibusaburo Kitasato, Charles T. Ramsden and N. Charles Rothschild. The same institution has appointed as delegates to the Nineteenth International Congress of Americanists, Charles D. Walcott and H. Newell Wardle.

At the annual meeting of the New Orleans Academy of Sciences, held at Tulane University on March 17, William Benjamin Gregory, professor of experimental engineering in Tulane University, was elected president of the academy for the ensuing year.

Mr. James A. Barr has been appointed director of congresses for the Panama Pacific Exposition.

Professor Elwood Mead has reconsidered the acceptance of a professorship of rural institutions in the University of California, and will remain chief engineer of the commission of rivers and water supply of the state of Victoria.

The United States Department of Agriculture has established an office in the bureau of chemistry for the purpose of promoting a closer and more cordial cooperation among the city, state and federal food and drug officials of the country in the enforcement of the food and drug laws. Mr. J. S. Abbott, for nearly seven years dairy and food commissioner of Texas, was appointed to this office and began active service on April 3, 1914.

The Howard Taylor Ricketts prize for undergraduate research work, awarded on May 3, each year, as a memorial of the death of Howard Taylor Ricketts while engaged in the investigation of typhus fever in Mexico City, is this year awarded to Julian Herman Lewis.

The Hunterian Society's Medal, offered annually for the best essay by a general practitioner, has been awarded to Dr. Basil T. Parsons-Smith, who took for his subject, "The Intermittent Pulse."

The Helen Schaeffer Huff memorial research fellowship at Bryn Mawr College has been awarded to Miss Vernette Lois Gibbons, who will continue her investigation of the potentials of the metals in non-aqueous solutions.

The trustees of Clemson College have appropriated $300 for an investigation of the limestone and marl deposits of South Carolina and their value for agricultural purposes. The work will be in charge of Dr.

F. H. H. Calhoun, professor of geology and mineralogy.

DR. L. J. HENDERSON, assistant professor of biological chemistry, has been appointed the professor from Harvard University for the second half of the year 1914–15 under the interchange agreement between Harvard University and the four western colleges—Beloit, Grinnell, Knox and Colorado.

PROFESSOR PERCY E. RAYMOND, of Harvard University, has left for an expedition under a grant from the Shaler Memorial fund to explore regions about the Baltic.

PROFESSOR G. D. HARRIS, of Cornell University, will leave Ithaca early in June in a thirty-foot motor boat to take an inland trip down the Atlantic coast for the purpose of studying the geological formations on the route and to add to the university's collection of geological specimens. He will be accompanied by six or eight graduate students who are specializing in paleontology.

PROFESSOR J. H. LEUBA, of Bryn Mawr College, will be absent next year on sabbatical leave. His work will be taken by Professor E. Wilm, now at Wells College and by Dr. Chester E. Kellogg.

THE University of Pennsylvania Chapters of Phi Beta Kappa and Sigma Xi held their annual joint meeting on May 1, when an address, entitled "The Whole Man," was made by Professor R. M. Wenley, of the University of Michigan.

ON the evening of May 4, Professor C. J. Keyser delivered an address before the Phi Beta Kappa Alumni in New York on "Science and Religion: the Rational and the Superrational."

DR. L. A. BAUER gave the following course of illustrated lectures at the Johns Hopkins University:

May 4, "The General Magnetic Survey of the Earth. I. The Chief Phenomena and Instruments of Investigation used in Ocean and Inland Work."

May 5, "The General Magnetic Survey of the Earth. II. The Results and Bearings of Magnetic Observations."

May 6, "The General Characteristics of the Magnetic Fields of the Earth and of the Sun and Results of Analyses."

May 7, "Résumé and General Theories."

PROFESSOR GUSTAV KILLIAN (Berlin), who will deliver the Semon Lecture at the house of the Royal Society of Medicine, on May 28, has selected for his subject, "Suspension Laryngoscopy and Its Practical Use."

THE Romanes lecture at Oxford University will be delivered on June 10, by Sir Joseph John Thomson, professor of experimental physics at Cambridge. The subject is "The Atomic Theory."

A CONFERENCE under the auspices of the Société des Amis de l'Université de Paris has been held to consider the subject of the fourth centenary of Andreas Vesalius, the great anatomist, who was born in Brussels in 1514. The plan is to erect a monument to his memory on the island of Zante where he died in 1564, next August, under the auspices of the Belgian government.

PROFESSOR NEWTON HORACE WINCHELL, formerly state geologist of Minnesota and professor of mineralogy and geology at the University of Minnesota, died on May 3, aged seventy-five years.

PROFESSOR EDUARD SUESS died on April 26 of pneumonia at the age of eighty-three. Until his eightieth birthday he had been president of the Vienna Academy of Sciences. Professor Suess was not only the dean of modern geologists, but a Liberal politician of the old school, whose parliamentary activity was largely directed against the organized forces of professional obscurantism.

DR. OTTO MAY, honorary professor of agriculture at the Technical School at Munich, has died at the age of eighty-one years.

THE Swiss Society of Neurology has called an International Congress of Neurology, Psychiatry and Psychology to be held at Berne, September 7–12, 1914. An organization committee and various international committees have been appointed.

THE committee having in charge the Samuel D. Gross prize, valued at $1,500, of the

Philadelphia Academy of Surgery, announces essays in competition for the prize will be received until January 1, 1915. The essays, which must be written by a single author in the English language, should be sent to the "Trustees of the Samuel D. Gross Prize of the Philadelphia Academy of Surgery, care of the College of Physicians, Philadelphia."

The board of governors of the General Memorial Hospital, New York City, have voted to enter into an affiliation with Cornell University Medical College for the conduct of the General Memorial Hospital as an institution for the study and treatment of cancer and allied diseases. This affiliation is rendered possible by the gift of a large sum from Dr. James Douglas, which, in addition to the present endowment of the institution will render the hospital largely independent of an income from other sources. The grounds for an affiliation are to be found in the facts: (1) That this institution was originally created for the purpose of cancer treatment and research, but the original funds were insufficient to enable it to enter this field exclusively. (2) The board of governors feel with Dr. Douglas that the study of cancer and the development of the new means of its treatment can be successfully carried out only through the combination of the efforts of laboratory workers specially trained in this field and clinical surgeons. The laboratory staff maintained by the college and the Huntington Fund is available for this work and the medical board of the hospital will be composed of such men, together with the surgeons, as are specially interested in cancer treatment and research. All forms of tumors and malignant diseases as well as cancer are to be included in the scope of the work. The institution duplicates on a large scale other hospitals which have been created in this country and abroad for similar purposes, the best known examples of which are Middlesex Hospital in London and the Samaritan Hospital of the University of Heidelberg.

As a result of recent experiments conducted by a member of the advisory committee on the Langley Aerodynamical Laboratory of the Smithsonian Institution, a new form of flying-boat hull has been evolved, which appears to have decided advantages over the types now in use. These experiments were made by Naval Constructor H. C. Richardson, U. S. N., chairman of the subcommittee on hydromechanics in relation to aeronautics of the Langley Laboratory, at the model basin of the Washington Navy Yard. Several model hulls were used, some of which represented the different types of naval hulls now in use, one a model of the Curtiss pontoon, and others obtained through changes and improvements in standard forms. They were one ninth full size, except the Curtiss model which was one fourth actual size, and were tested both on the surface of the water and submerged one foot. In his report Naval Constructor Richardson has shown by diagrams and tables the advantages and disadvantages of the various types, as well as the plan, side and end views of five models. Tests were made on the surface of the water for the resistances at "displacements corresponding to speeds," and other tests were made submerged as a means of determining their total head resistance in air, and of ascertaining an approximate coefficient of fineness of form. Further experiments are under way for the determination of the stream line flow about submerged models, as a means of improving the form, and to otherwise perfect the standard type most advantageous for all purposes. Comparisons of the model results and the actual performances of full-sized machines show that a fair analogy exists, confirming the behavior of the models under experiment. Actual experiments with a full sized machine shows the hollow V section very desirable because of the good landing qualities, as landings which would otherwise stress the machine badly have been made without any shock. The report of the experiments forms Publication No. 2253 of the Smithsonian Miscellaneous Collections.

UNIVERSITY AND EDUCATIONAL NEWS

The gifts to Oberlin College for various purposes during the last months amount to nearly $190,000, apportioned as follows: For campus

improvement, $25,000; for a new art building, $125,000; for a new organ in Finney Memorial Chapel, $25,000; subscriptions toward the new athletic field, $14,300. A large number of gifts, mostly anonymous, go to make up the $125,000 for the new art building.

DR. BEVERLY THOMAS GALLOWAY, assistant secretary of the Department of Agriculture and previously chief of the Bureau of Plant Industry, has been appointed by the trustees of Cornell University to be director of the New York State College of Agriculture. Dr. Galloway takes the place which was vacated by the resignation of Professor L. H. Bailey and which has been filled this year by Professor W. A. Stocking as acting director.

AT the University of Missouri, Dr. I. F. Lewis, of the University of Wisconsin, has been appointed professor of botany, and Professor E. J. McCaustland, of the University of Washington, dean of the engineering faculty and director of the engineering experiment station.

WALTER COLLINS O'KANE has been elected professor of zoology and entomology at the Ohio State University. He graduated from the university in the class of 1897 and has been connected with the New Hampshire station for the past four years.

AT Cornell University, George A. Works has been elected professor of rural education in the college of agriculture, and David Lumsden assistant professor of floriculture.

DR. GERTRUDE KAM, demonstrator in psychology at Bryn Mawr College, has been made an associate.

DR. DOUGLAS MCINTOSH, associate professor in McGill University, has been appointed associate professor of chemistry and acting head of the department in the newly established University of British Columbia.

DISCUSSION AND CORRESPONDENCE

A NOTE ON THE ACCESSORY CHROMOSOMES OF MAN

IN two recent publications in which Montgomery's and my own observations on the accessory chromosomes in man (negro) have been mentioned, the phraseology of the authors would lead any one who had not read the original papers to the conclusion that there was a decided discrepancy in our results, whereas just the reverse is true. Thus Morgan in his book, "Heredity and Sex," after remarking on my account of the accessories says (p. 245):

> Montgomery has also studied the same problem, but his account while confirming the number, is in disagreement in regard to the accessory.

And again Kornhauser, in his "A Comparative Study of the Chromosomes in the Spermatogenesis of *Euchenopa Binotata*, etc.," *Arch. f. Zellforsch.*, Bd. XII., No. 2, speaking of cases in which "the x-element is in the form of two chromosomes in the male" as found by Wilson in *Syromastes*, continues (p. 280):

> Guyer ('10) has reported a similar condition in the spermatogenesis of man. This case, however, would seem to need confirmation, for both Gutherz ('12) and Montgomery ('12) have, in the main, been unable to support Guyer's contention.

This last is certainly a surprising statement for any one to make who has read Montgomery's paper, as the following excerpts from his "Human Spermatogenesis, Spermatocytes and Spermiogenesis, A Study in Inheritance," *Jour. Acad. Nat. Sci. Phila.*, Vol. XV., 2d Series, 1912, well attests. Speaking of the chromosomes of the primary spermatocytes he says (p. 8):

> I can confirm Guyer's conclusion that there are 12, of which 10 are bivalent gemini, each dividing in both maturation mitoses, and 2 univalent allosomes (accessory chromosomes) which divide only once in the two maturation mitoses. Guyer's view is therefore probably correct that the number in the spermatogonia must be 22 and not 24 as reasoned by Duesberg.

There is a slight discrepancy in Montgomery's and my account of the subsequent behavior of the accessories but even here we agree in the main, for speaking of the ordinary behavior of the accessories Montgomery continues (p. 9):

> This is the usual condition and the one discovered by Guyer.

As a matter of fact, the discrepancy lies in the fact that, in addition to this usual behavior, Montgomery records certain atypical cases as follows: five cases in which the members of the double accessory go to opposite poles; ten cases in which the smaller member of the pair divides, one half going with its customary associate to one pole, the other half going alone to the opposite pole; five cases in which the larger member divides; three cases in which both accessories divide. On looking over my material again since the appearance of this and other papers on human spermatogenesis, and also after the examination of some new negro material received in the meantime, I still feel convinced that conditions for the male negro are essentially as I originally described them.

The most decided differences in accounts of human spermatogenesis are those which obtain between the findings of Montgomery and myself on the one hand and von Winiwarter on the other. The latter finds 47 ordinary and one accessory in the male. It must be borne in mind, however, that Montgomery and I worked on the tissues of negroes and von Winiwarter on those of a white man. I am at present engaged in a study of material from two different white men and although not yet ready to make a detailed statement I can say with assurance that the number of chromosomes is considerably in excess of those found in my negro material.

Michael F. Guyer
The University of Wisconsin,
April 3, 1914

Moral and Religious Training in a State University

To the Editor of Science: Chancellor Frank Strong's paper in Science of November 21, on "Some Educational Problems in Kansas," mentions as one of the great problems confronting education in that state "moral and religious training," saying:

> If any were misled years ago into the belief that intellectual training provided sufficient safeguards and moral standards, certainly our experience the last decade must have disillusioned him.

The "if" is a saving word in that statement, to any who might be disposed to disagree with the chancellor, but it still seems a fair question to ask, How otherwise than through the intellect is education of any kind to be conveyed? Also, it would seem to be not altogether out of place to inquire as to exactly what is meant by the terms "moral" and "religious," not to obtrude a discussion of religion in a publication devoted to a quite different purpose, but to make clear the intentions and plans of those, like Dr. Strong, who insist that education is incomplete and dangerous without the application of certain remedies which they have to offer. A few are interested in religion, but all of us in education.

If the meaning of the terms refers to acts of worship, which in their nature are emotional and suggestive rather than instructive, such as prayers, the reading of scriptures and singing of hymns, it is a popular understanding that it is the function of the church to attend to such things, not the high schools, colleges and universities, for in such institutions Jews, Catholics, Greeks, Turks, Chinese, Japanese, Mormons and agnostics often mingle, all with such divergent beliefs touching religion that creedal or sectarian teaching and forms would be wholly out of place. Such students place themselves under instruction to learn the truths of science and history and to study art, literature and languages, not to be proselytized. Like the purchaser of a commodity in trade, they come to buy what they think they need, not what some one else wants to force on them, and if they are forced, in order to get the instruction needed, to take other kinds which are repugnant to their religious convictions, it becomes tyranny.

As to morals, there is no dispute among civilized peoples generally in all parts of the world. Honesty, truthfulness, mercy, forgiveness, unselfishness, restraint of passions, honoring parents—"these and a few others," as Buckle truly said, "have been known for thousands of years, and not one jot or tittle has been added to them by all the sermons, homilies and text-books which moralists and theologians have been able to produce." There could be no objection, of course, to their being taught in the schools if it seemed necessary—

taught directly, not by the subterfuge that they could only follow from religious acts, therefore it is necessary to teach religion—but if made a part of the curriculum I should like to know how large a place our professors would be likely to assign them. Would a three years' course seem too short, or a four year, perhaps, too long to teach a boy that honesty and good habits are right, and the opposite are wrong? Or would such things be assumed to have been taught during childhood in the only proper place—at the mother's knee?

Since Chancellor Strong lays emphasis on the statements, that "after all . . . ours is a Christian civilization," and "Historical Christianity is the basis of our whole life, and we as a nation shall stand or fall with it," he must then mean by the "moral and religious problem confronting education in Kansas as elsewhere" the question of how to bring about the teaching of Christianity by compulsion and at national or state expense, an attempt as out of joint with the times as with the purpose of the founders of the country, that church and state should be forever separate.

HENRY K. WHITE
CATONSVILLE, MARYLAND

SCIENTIFIC BOOKS

THE EASTMAN-ZITTEL PALEONTOLOGY

THE appearance of a second and very much enlarged edition of Dr. Eastman's English version of Zittel's "Paleontology" (Volume 1, Invertebrates) may be accepted not only as an acknowledgment of the usefulness of the work but also as a response to a growing interest in the study of ancient life. It is very probable that the justification for the revision of this expensive and elaborate work comes chiefly from the American demand, and, if this is true, the demand may perhaps be counted among the first fruits of the efforts made by The Paleontological Society to encourage and widen a deeper concern in that field. While this statement has reasonable worth, yet the fact stands out clearly that the Eastman-Zittel "Paleontology" is by far the best, practically the only satisfactory general guide-book and compendium of the science. Even the first edition was a more useful book than the German original because of its greater detail and closer analyses, though we have been given to believe the innovations in classification introduced by the first collaborators were not altogether acceptable to the lamented and distinguished author, Professor Zittel. But in a science which covers the whole field of life, progress must be rapid; new encyclopedias soon become old as new lands are explored and old ones more closely scrutinized, and old philosophies and classifications give way under the burden of new knowledge. No one person could to-day successfully do what Zittel did—write a book covering the entire field of ancient life. Versatile as he was in many departments of paleontology, competent to expound as he did the structures of sponges and dinosaurs, to-day such diverse efforts would be looked upon with a grave hesitancy by students generally, that would assuredly weaken the voice of authority.

So, in this new book, there is a divided authority, even more pronounced than in the first edition, and the American author, Dr. Eastman, modestly withholds his own name from any acknowledged responsible share in the separate chapters, which leaves us to infer that he did all the work the others did not do (no small amount when one analyzes the allotments) and of course did the real work on the rationale of all the combined chapters.

In giving to SCIENCE a notice of this work, it seems appropriate to restrict it essentially to the new material, either in the form of accretions from later discoveries or of revised classifications, and to present these new features succinctly and with precision the reviewer has asked most of the contributors to briefly state the differences between the old and the new in the chapters with which they have been severally charged.

In the 1899, or first, American edition there were 12 collaborators; in this edition of 14 years later there are 17 coworkers, and but three names of the first list remain on the last: Dr. Dall, Professor Schuchert, Mr. Clarke. The increase in the number speaks of greater refinement of knowledge as well as of wider activity of research in the later years.

The Foraminifera (Joseph A. Cushman) have been given a fuller introductory discussion and the classification is essentially made over. Though without additional illustration, the chapter is essentially new.

The Porifera have been amplified (by the author-editor) with additions on the Hexactinellids, and it is interesting to note the elevation of *Receptaculites* and *Ischadites* from a footnote to a place in the text body.

Regarding the Anthozoa, which have been revised by T. Wayland Vaughan, the editor remarks that the classification adopted, "although perhaps as good as any available, is tentative in character." Among the Tetracoralla there are few changes; in the Hexacoralla Dr. Vaughan has added some important text and illustrations in the general discussion and in the classification are some noteworthy alterations. We notice the family Fungidæ and its allies created into a suborder Fungida, and the omission of the Madreporidæ (on the assumption that they do not occur fossil). The extensive array of tabulate corals or favositids is no longer an "appendix to the Hexacoralla" as in the first edition, but more conservatively expressed as an "appendix to the Anthozoa." Into this group *Chætetes* is admitted, but *Monticulipora, Fistulipora* and their allies are put back again among the Bryozoa.

The Graptolitoidea (R. Ruedemann) formerly standing in an "Appendix to the Campanulariæ," are likewise more broadly considered as a "Class or Subclass of the Hydromedusæ." This chapter has been considerably enlarged in text and illustration and the taxonomy rectified by substituting for the oddly incongruous *subordinal* terms of the early edition Monoprionidæ, Diprionidæ, etc., the classification wrought out in the author's well-known memoir on these organisms.

The Vermes have been amplified by the introduction of Walcott's recent remarkable discoveries in the Cambrian.

A number of collaborators have revised the Echinodermata: Frank Springer, the Cystoidea, Blastoidea and Paleozoic Crinoidea; Mr. Springer, with A. H. Clark, the Post-paleozoic Crinoidea; H. L. Clark, the Asteroidea and Holothuroidea, and R. T. Jackson, the Echinoidea. These are distinguished authorities and the amendments they have made must be regarded as well up to the present state of knowledge of these groups. In Mr. Springer's part of the work there is an enlargement of about nineteen pages, and in the classification of the Crinoidea the two authors have rearranged the divisions in better harmony with their geological succession and their recognized structural relation. A striking feature is the inclusion of the stalked pentacrinites and the unstalked comatulids in one family and the union of the genera *Marsupites* and *Uintacrinus* with the comatulids.

A singular and rather confusing thing in this connection is an incongruity in classification which must have escaped the author's eye. The family Pentacrinidæ is divided into three sections, one of which, the "comatulids," is divided into three "tribes." The second of these tribes is made to contain many genera grouped into a large number of different *families*.

Mr. H. L. Clark has given an entirely new classification of the Asterozoa and has amplified the chapter on the Holothurians, including even the Cambrian species discovered by Walcott, though he has elsewhere gone on record as doubting the echinoderm nature of these fossils.

The Echinoidea have been brought up to the stage of Dr. Jackson's exhaustive knowledge of the group, expressed in his recent elaborate treatise on these bodies. New cuts are introduced, some showing structural characters of the group as a whole and others representative Paleozoic echini. In the classification the arrangement is in natural phylogenetic sequence based on a comparative study of development and adult structures.

In the Bryozoa by R. S. Bassler, the Monticuliporoids, which in the last edition were made to appear in the "double and daring act" of both Bryozoa and Anthozoa, are now excluded from the latter, as just observed, because of the recent demonstration of their early budding phases. A revised classification

is presented of the Cyclostomata, with 5 suborders, one of them, "Ceramoporoidea," being new; a natural division given of the *Trepostomata* and the most recent work on the *Cheilostomata* is included.

In the Brachiopoda (Charles Schuchert) the form of the chapter and the general principles of the classification have been retained, but the latter has not only been elaborated to such completeness as to assemble all outstanding generic divisions of which the later years have added no small number, but have been illuminated by the expression of phylogenetic lines and terminals. This procedure has made necessary the introduction of a good many new divisions of supergeneric value, but it conveys a conception of developmental relationships never before so well expressed.

The chapters on the Pelecypoda, Gastropoda and Pteropoda have undergone no material changes except for the inclusion of new generic terms (W. H. Dall), but in the Cephalopoda by J. Perrin Smith there are notable expansions in both matter and illustration. For some reason the Nautiloidea have been left pretty much as they stood before, though a great deal of work has been done on the group in the last 14 years by Germans and Americans; but the Ammonoidea have been amplified by many new cuts of Carbonic, Permic and Triassic forms. It will surprise many students of this group to find Hyatt's classification, adopted in the first edition, quite entirely cast out in favor of the German taxonomy as expressed by Zittel and of late years amplified by European students and by Dr. Smith, himself a collaborator with Professor Hyatt. The present classification is in a way a trial adjustment of the old and the new.

The Trilobites have been revised by P. E. Raymond, who has enlarged the generic list from 55 genera in 14 families, as in the first edition, to 126 genera in 28 families; a statement which indicates the persistent and growing interest in this group of fossils. The principles of the classification are those followed by Beecher in the first edition. The reviser has incorporated his own interpretation of many old and rather vaguely defined names, such as some of Corda's and Angelin's, with a generous number of new generic conceptions based upon his own researches.

The Branchiopoda and Ostracoda have been brought up to date by R. S. Bassler with a considerable number of new figures. The Cirripedia and Malacostraca (by William T. Calman; Phyllocarida by J. M. Clarke) are not materially unlike their earlier presentation, while the Arachnida-Merostomata (J. M. Clarke) have been considerably revised with some substitution of old for new illustration, especially of restorations based on the researches recently published by Clarke and Ruedemann. The Arachnida-Embolobranchiata (Alexander Petrunkevitch) are brought into line with recent discoveries with some additional illustration, and the Myriapoda stand very much as they were left in the old edition.

Mr. Anton Handlirsch's chapter on the Insecta is a wholly new and original document of thrice the text matter and twice the illustration of the former edition. The general discussion and the classification are so entirely unlike the original that even a trace of the latter is hard to find. It may well be regarded as the best present expression of information regarding this group.

JOHN M. CLARKE

School Health Administration. By LOUIS W. RAPEER, New York Training School for Teachers. Published by Teachers College, Columbia University, New York City.

Part I., pp. 1–70, gives an outline of national health problems in their relations to the school. Part II., pp. 71–294, summarizes the findings of an intensive study which the author has made of the methods and results of school medical service in twenty-five typical cities in the eastern states. Part III., pp. 295–358, offers a tentative standard plan for the administration of school health work.

The book is the fruit of several years of first-hand investigation of the methods of medical inspection as it is actually carried on. The author goes behind the glowing accounts

found in the reports of superintendents and school doctors, and measures the efficiency of the systems by the application of a few common-sense statistics and the principles of scientific management. He shows in a most convincing way the inefficiency of some of the methods in vogue and offers a plan which ought to be taken as a model until experience shall have given us something better.

The book reveals a broad grasp of the larger significance of educational hygiene, and points clearly to the many dangers of misplaced emphasis in this new but promising field of child welfare. It should be studied especially by school superintendents, school doctors, school nurses and social welfare workers.

The appearance of the book is somewhat marred by a rather unattractive make-up; and the author's style, while vigorous and interesting, is not always as direct and clear as one would like.

Lewis M. Terman

Stanford University

INVESTIGATIONS IN THE ATLANTIC OCEAN[1]

Measurements of the temperature and salinity of the surface water of the Atlantic Ocean have for many years been carried out by route steamers and other vessels traversing these waters. The necessity of systematically conducted investigations, of both hydrographic and biological character, not only at the surface, but also in deep water, is pointed out. Such a systematic investigation of the whole of the Atlantic Ocean must be regarded as one of the most important scientific and practical tasks of the future.

Pettersson and Drechsel were intrusted by the Central Bureau of the International Study of the Sea, with the task of drawing up a memorandum as to the ways and means by which an international reconnaissance of the Atlantic Ocean could be organized in the near future. These gentlemen have conferred with many of the leading authorities on oceanography in other countries.

The authors concluded, as the result of such conferences, that the matter could not be farthered by the ordinary discussions and resolutions on the part of learned societies. The only way was to seize the first favorable opportunity of commencing the investigations. The first trans-Atlantic hydrographical investigation would probably have to be made from ships in the naval service. Coastal seas could be studied only by real investigation steamers, specially fitted for fishery-biological work.

The following program was drawn up:

I. Investigation of Coastal Seas;

II. Transatlantic Investigation.

These investigations are to be carried out simultaneously, since in this way a more comprehensive view can be obtained of the actual condition of the Atlantic Ocean in summer and winter. After the general survey has been made, special investigations of individual questions can be taken up. To complete such investigations it is important that the countries bordering on the Atlantic Ocean should cooperate. Great Britain and the United States have already cooperated, and France and Canada should also participate. For the investigation of the coastal seas, the following program is suggested.

(*a*) Quarterly cruises to be made to the *northeastern part of the Atlantic water system*, from Iceland to Spitzbergen, including the North Sea, the Skagerack, the Cattegat and the Baltic.

(*b*) In reference to the Iceland-Faeroe-Wyville Thomson ridge, the Rockall channel and the mouth of the Channel, it is to be hoped that the former will be investigated by the Scottish, Danish and Norwegian commissions, and the mouth of the Channel by the Irish Fishery Department.

(*c*) In the sea east and west of Greenland the determination of the conditions with regard to ice is of prime importance. The Danish Meteorological Institute has already done good work in this field.

(*d*) We do not possess a single hydrographical section through the Labrador current, and

[1] Abstract of a report by Petterson and Drechsel. The address of Pettersson is: Professor Otto Pettersson, Holma i Brastad, Sweden.

yet this current plays such a prominent part in the water circulation of the Atlantic. Some observations are already being made in connection with the shipping interests.

(*e*) In reference to the Coastal Sea of North America, discussed under caption (*e*), it is pointed out that hydrographic observations should be obtained over the area extending 600 miles south 30° east of St. Johns, Newfoundland, returning directly to the Flemish Cape and thence to St. Johns. Also at other points on the "Grand Banks" and neighboring fishing grounds. It is also recommended that quarterly cruises be carried out in the months of February, May, August and November from Cape Lookout to the Bermudas and thence to Florida. Monthly observations should be made on section between southern Florida and Nassau, and between southern Florida and Havana; also in the Atlantic Ocean north of Cape Hatteras.

(*f*) The Newfoundland Bank and adjacent waters are both scientifically and practically the most interesting area for study, since it is here that we have the conflict between the Gulf Stream and the Labrador current. The bearing of the results obtained on the fishery question would be very direct and very important. The fact that the fishery on the Grand Banks is seasonal would indicate an annual periodicity in the hydrographical conditions. Ways and means are not yet worked out for connecting the study of the Newfoundland Banks with a future, general study of the North Atlantic Ocean.

(*g*) The Portuguese coast and the Plateau of the Azores can be investigated largely by the Portuguese, who are very much interested in the problem. With the permission of the Portuguese government, two cruisers can make quarterly cruises into these regions.

Transatlantic lines of investigation can be carried out only by direct government aid. To secure this cooperation on the part of the different governments, it is necessary to have a well-arranged program, and to select some "favorable opportunity" for carrying it out. The following program and opportunity are suggested.

The Program

The basin of the Atlantic is divided into two great hollows by a submarine ridge running out from the Cable Plateau. The eastern and western hollows have different hydrographical conditions. The simplest plan would be to draw the transatlantic line of investigation parallel with the degrees of latitude between America and Europe. The northernmost of the three sections should be studied approximately along the fifty-seventh degree of latitude. This would be comparatively simple. The depths of the Cable Plateau are only from 1,000 to 3,000 meters, and this section would cross all of the so-called "Gulf Stream Branches" in the north Atlantic.

The southern sections should be drawn not transversely, but diagonally. One should extend from the mouth of the Channel north of the Plateau of the Azores to the West Indies and the Caribbean Sea. The second should extend from the Straits of Gibraltar south of the Plateau of the Azores to Trinidad.

The study of those two sections would demand a complete equipment for oceanic deep-water soundings, and a staff experienced in such work on board large ships. The best time would be from December to February, since our knowledge of the condition of the sea is especially incomplete in winter.

The Opportunity

It appears opportune that the first Atlantic survey should be made with ships from the Navy, at a time when such vessels are sent out simultaneously from several European countries along the several routes indicated above. Such an opportunity will present itself at the opening of the Panama Canal in January, 1915. European countries will probably be represented by naval vessels, and scientific investigations could be made *en route,* without great expense or serious loss of time.

The Austrian and Italian vessels, coming through the Straits of Gibraltar, could study the southern section. Since a deep-sea sounding requires only about twelve hours, and a sounding of 1,000 meters only a few hours,

the scientific work would not lengthen the voyage more than a week.

The ships sent by the North Sea countries and by Russia, coming through the English channel, could study a section of the Atlantic north of the Plateau of the Azores. The opening of the Panama Canal, which should stand for universal traffic, would likewise form an epoch in the study of the sea, and introduce a future of international cooperation in the scientific activity of nations.

If this opportunity is neglected, it is not likely soon to come again. Experience has taught the difficulties involved in setting in motion an international undertaking of such dimensions; and the opinion is expressed that the time remaining would just about suffice for the diplomatic, scientific and technical preparations.

In preparing the above synopsis the words of the authors are frequently used.

H. C. Jones

SPECIAL ARTICLES

THE POOR NITRIFYING POWER OF SOILS A POSSIBLE CAUSE OF "DIE-BACK" (EXANTHEMA) IN LEMONS

The disease known as "die-back" in citrus trees has, for many years, worried the citrus growers of Florida and California in this country and has thus far baffled the efforts of the agricultural scientist to discover its cause. The writer has recently made some observations and experiments on several citrus soils bearing trees affected with "die-back," which lead him to believe that a poor nitrifying power on the part of the soil, with the ammonifying power remaining normal, may be the cause of the peculiar manifestations which are characteristic of the disease and which, for the purposes of this preliminary report, need not be described. The theory upon which I am working at the present time, looking toward the solution of this problem, is that in the absence of normal nitrification and in the presence of sufficient ammonification, the tree does not obtain a sufficient quantity of nitrate for its development and is sooner or later forced to assimilate ammonia compounds as produced by ammonifying organisms in the soil; or in the presence of a sufficient amount of bases in the soil even the ammonia may be set free, thus causing the plant to starve for want of nitrogen. While it is true that some plants can use ammonia compounds just as well as nitrates as a source of nitrogen and further, that some of them even prefer the ammonia compounds, as Kelley has shown is the case with rice, it is very possible that we have in the citrus tree, a plant which is deleteriously affected by ammonia compounds when it is forced to absorb them. As above explained, however, when a soil's power to fix and hold ammonia is very feeble, owing to the presence of bases in excess, a poor nitrifying power and a strong ammonifying power may mean nitrogen starvation for plants on that soil. The writer has examined and tested the nitrifying power of four citrus soils in various parts of California, on which trees were suffering from "die-back," and has found in every case a very slight nitrifying power or none at all. The tests were made by adding to soils, kept at optimum moisture conditions at a temperature of 26 to 28 degrees C. for approximately a month, both dried blood and sulfate of ammonia, but only slight or no increases of nitrates over the amount in sterile checks or dry soil were obtained. The dried blood was used also in varying quantities from 1 per cent. up to 5 per cent. of the dry weight of the soil, but the same results were obtained in all cases. In some of these soils, particularly, the ammonification of the blood proceeded so rapidly as to give an intense odor of ammonia when the Petri dish cover was raised from the tumbler in which the soil cultures were kept.

This theory of the writer's which inclines to account for the "die-back" by the fact that too much ammonia is assimilated by the tree under compulsion in the absence of nitrates, or, under certain circumstances, because ammonia is set free and therefore there is scarcely any nitrogen for the tree to assimilate, would also seem to be in part confirmed by the observations made by Florida investigators on the disease in question, in which it was noted that in all cases the application of organic

manures to citrus groves invariably made conditions worse or increased the amount of "die-back." In accordance with the idea above expressed, and in the absence of nitrification, this would be for the reason that either the added organic matter would be responsible for the formation of so much ammonia, which (through its enforced absorption) would poison the plants or because, under some soil conditions, most of the ammonia would be set free and pass off into the atmosphere in a gaseous form, thus inducing nitrogen hunger.

I feel justified in transmitting this brief preliminary note on the subject in question, before the theory has been fully tested out, by the fact that the disease known as "die-back" has been studied in many different ways without giving encouraging results, and, because, further, this new method of attack related to the chemical and bacteriological conditions of the soil, as affecting plant nutrition and as applied to a problem of this kind, deserves to be called to the attention of other investigators working along this or similar lines. I am vigorously proceeding to test out the theory above given by simultaneous greenhouse and field experiments with citrus trees which are now under way, in which, on the basis of what I have said above, I am not only trying to overcome the disease by variously treating soils in the field, so as to provide a plentiful supply of nitrates and reduce ammonification, but I am also making an effort to produce the disease experimentally in the greenhouse with seedling citrus trees on soils deficient in nitrates by the addition to the latter of various ammonia compounds, and to overcome it by means of adding stimulants for the nitrifying bacteria. The writer feels confident that a definite relationship may be shown between the abnormal soil conditions mentioned and the "die-back" of the lemon and perhaps as well of other citrus trees, when the experiments have progressed far enough. The theory above enunciated is not only in accord with the Florida observations, but also with all other observations with which I have become acquainted in respect to the disease known as "die-back." Moreover, it allows for the production of bad soil conditions which will result in a poor nitrifying power through a large variety of causes. Such are, for example, the poor physical conditions of soils, unfavorable drainage conditions, the presence of a vigorous denitrifying flora of one kind or another, and many other chemical, physical and bacteriological conditions, not to mention conditions respecting the origin of the soil which would seriously affect the nitrifying power thereof.

These lines for the most part were written about a year and a half ago when I first formulated the theory, and may need slight revision and some additions in the light of many new facts with which we are now acquainted, but, in the main, the theory seems to be better supported in fact at the present time than it was two years ago. Moreover, it seems very probable now, from a large series of tests which we have been making, that not only "die-back," the true *exanthema,* is to be accounted for by the theory under discussion, but also that the equally disastrous, and much more widely spread disease known as "mottled leaf" of citrus trees is capable of being explained in a similar way, if I may regard a large series of tests on various soils in this state as a reliable criterion. Quite unlike the "die-back," the "mottled leaf" condition in citrus trees is to be found in all citrus districts of California, and is at the present time regarded as one of the most menacing factors in the production of citrus fruit for profit here.

The "die-back" and "mottled leaf" conditions of some districts in this state are becoming so bad as to make it imperative to solve these questions as quickly as possible from the practical standpoint alone. One orchard on which, in particular, the writer is working, has a very large proportion of its trees badly affected by the first-named disease, and most trees in the orchard show some manifestation of the disease. The trees are about four years old and had for a time grown vigorously, and then suddenly began to give symptoms of one of the worst and most widespread cases of "die-back" of which we have knowledge in the state. It is hoped that our experiments may serve eventually to remedy such conditions.

A description of detailed experiments will soon appear.

Chas. B. Lipman
Research Laboratory for Soils,
University of California

THE WATER CONTENT OF THE EMBRYONIC NERVOUS SYSTEM

Growth and morphological differentiation go hand in hand in the developing organism, but obviously growth alone can not lead to an increase in the complexity of form without itself being differential. The various tissues and organs of the embryo, however, do grow at different rates, and since, in general, rate and extent of growth are measurable in terms of the rate and extent of water absorption, it follows that differential growth must depend on the ability of the embryonic tissues to absorb and hold, relative to their dry substance, different amounts of water. That this must be true at some period in development follows from the comparative dry substance determinations familiar to every one, but how early in the ontogeny differential absorption occurs has not been known, although its importance as a factor in morphological differentiation has been hinted at often enough.

My investigation of this question was begun on the embryos of *Rana pipiens* in the spring of 1913. The methods employed were tedious but simple. In one series of experiments eggs were allowed to develop normally until a time when the body of the embryo could be cut from the yolk by means of a very thin knife. The division was accomplished easily with a minimal loss of material. Unfortunately the various tissues in the separated portions can not be isolated, but even if this were possible, an unavoidable error due to the presence of considerable quantities of yolk within the cells of the nervous system would remain. However, at the stage of development under consideration, it is safe to assume that the operation results in the separation of two masses, one of which is predominantly yolk, the other, predominantly nervous tissue.

The separated masses were carefully weighed in closed vessels after removal of the superficially adhering water. Following the determination of the fresh weight, the material was reduced to absolute dryness in vacuo over P_2O_5. The results of two series of weighings given in Table I. are:

TABLE I

(*Rana pipiens*)

	Fresh Weight, Gr.	Dry Weight, Gr.	Dry Substance, %	Water, %
24 yolk sacs	.0440	.0204	46.4	53.6
31 yolk sacs	.0585	.0264	45.2	54.8
Average			45.8	54.2
24 nervous systems	.0464	.0098	19.1	80.9
31 nervous systems	.0714	.0149	20.8	79.2
Average			19.9	80.1

Control observations on embryos of *Amblystoma punctatum* were then made, but, owing to technical difficulties, it proved easier to compare the water content of the nervous system with that of the entire embryo rather than with that of the tissues constituting the yolk sac. The results of these preliminary determinations were as follows:

TABLE II

(*Amblystoma* larvæ)

	Fresh Weight, Gr.	Dry Weight, Gr.	Dry Substance, %	Water, %
16 larvæ	.0955	.0399	41.8	58.2
15 larvæ	.0992	.0406	40.9	59.1
Average			41.4	58.6

These figures may serve as a basis for comparison with the water content of the nervous system. As Table III. shows, the values for the latter are identical with those for the frog embryo, and belong to an order of magnitude quite different from the values for the larval body taken as a whole.

Comparing these values with the corresponding ones found for the frog embryos, we may say, within the limits of error, that the larval nervous system of these amphibians is a tissue which contains 80 per cent. of water and 20 per cent. of dry substance.

TABLE III
(*Amblystoma* larvæ)

	Fresh Weight, Gr.	Dry Weight, Gr.	Dry Substance, %	Water, %
52 nervous systems.....	.1756	.0400	22.8	77.2
15 nervous systems.....	.0524	.0106	20.2	79.8
69 nervous systems.....	.2039	.0363	17.8	82.2
Average.....			20.3	79.7

If we wish to institute a comparison between the water content of the embryonic nervous system and the corresponding adult structure, it is more correct to use the water content of the cord, for this is less differentiated than the brain and consequently more nearly resembles the larval condition. Donaldson[1] has given the water content of 12 cords of *Rana pipiens*. The average is 80.5—identical with my value of 80.1 for the larval system.

Comparisons were also made between the water content of the anterior and posterior ends of the embryonic nervous system. For this purpose I divided 125 isolated larval nervous systems of *Amblystoma* in two, as accurately as possible, in the medullary region. Dry substance determinations of the separated portions were then made with the following results:

TABLE IV
(*Amblystoma*)

	Fresh Weight, Gr.	Dry Weight, Gr.	Dry Substance, %	Water, %
125 larval brains.....	.1812	.0342	17.2	82.8
125 larval cords.....	.2102	.0443	21.0	79.0

These results are in the same sense as those reported by Donaldson,[2] as the water content of the brain of an adult *Rana pipiens* is 84.9 per cent., or 4.4 per cent. higher than that of the cord. My results on *Amblystoma* indicate that the larval brain contains more water than the attached cord.

[1] Donaldson, Henry H., "Further Observations on the Nervous System of the American Leopard Frog, *Rana pipiens*, etc.," *Journal of Comparative Neurology and Psychology*, Vol. 20, p. 2.

[2] *Loc. cit.*, p. 2.

We may conclude therefore that the nervous system as a whole has a specific capacity for holding water and that this specificity exists from the beginning. This can be the outcome of nothing other than a physical-chemical specificity, and we must suspect that the nervous system differentiates as a morphological entity, because its chemical differentiation endows it with a specific capacity for holding water. Moreover, two regions as sharply distinct, morphologically and physiologically, as brain and cord have each their own specific capacities, and these although not differing as widely, perhaps, as in the adult, are nevertheless at variance in the embryo in the same sense. The thought lies near at hand, therefore, that the gross structural differences between brain and cord brought about during the course of development are definitely related to the fact that their respective rudiments maintain each its own specific relation between the amount of dry substance and the amount of water.

OTTO GLASER

UNIVERSITY OF MICHIGAN,
April 3, 1914

CONFERENCE ON INDIVIDUAL PSYCHOLOGY

FORMER pupils of the department of psychology of Columbia University held a reunion and conference at the university, on April 6–8, and on the latter date gave a dinner to Professor James McKeen Cattell in celebration of the twenty-fifth anniversary of his first appointment as professor of psychology. This first appointment was at the University of Pennsylvania, and Professor Witmer, of that institution, one of Professor Cattell's earliest students, participated in the dinner. On this occasion a volume entitled "The Psychological Researches of James McKeen Cattell: A Review by Some of His Pupils," written by Messrs. Thorndike, Wells, Henmon, Dearborn, Hollingworth and Woodworth, was presented to Professor Cattell.

The program of the Conference follows:

Monday, April 6, at 3 P.M.

Chairman, PROFESSOR CATTELL

"Individual Differences in Sense Discrimination": V. A. C. HENMON (Ph.D., 1905), professor

of educational psychology, University of Wisconsin.

"Individual Differences in Reaction Time:" Sven Froeberg (Ph.D., 1908), professor of philosophy and psychology, Upsala College.

"Individual Differences in the Judgment of Unitary Colors": A. T. Poffenberger, Jr. (Ph.D., 1912), instructor in psychology, Columbia University.

"Possible Effects of Practise on Individual Differences:" Mary T. Whitley (Ph.D., 1911), assistant professor of educational psychology, Teachers College, Columbia University.

"Successive Measurements of Individual Ability": Warner Brown (Ph.D., 1908), associate professor of psychology, University of California.

Monday, April 6, at 8 P.M.

Chairman, Edward L. Thorndike (Ph.D., 1898), professor of educational psychology, Teachers College, Columbia University.

"Individual Differences in School Children": Elmer E. Jones (Ph.D., 1908), professor of the history and philosophy of education, Indiana University.

"The Reliability of Certain Psychological Tests for Determining the Mental Efficiency of Children": Frank G. Bruner (Ph.D., 1908), assistant director, department of child study, Chicago Public Schools.

"Feeble-minded Children as a Species": Naomi Norsworthy (Ph.D., 1904), associate professor of educational psychology, Teachers College, Columbia University.

"Correlations between Entrance Examination Grades and College Records": Adam Leroy Jones (Ph.D., 1898), chairman of the committee on undergraduate admissions and associate professor of philosophy, Columbia University.

Tuesday, April 7, at 3 P.M.

Chairman, R. S. Woodworth (Ph.D., 1899), professor of psychology, Columbia University.

"Cranial Measurements in Relation to Intelligence": W. C. Ruediger (Ph.D., 1907), professor of educational psychology, George Washington University.

"The Intelligence of Negroes": Marion J. Mayo (Ph.D., 1913), head of department of mathematics, Eastern District High School, Brooklyn.

"The Psychological Point of View in Ethnology": A. A. Goldenweiser (Ph.D., 1910), instructor in anthropology, Columbia University.

"A Note on Primitive Association of Ideas": Robert H. Lowie (Ph.D., 1908), associate curator of anthropology, American Museum of Natural History.

"The Measurement of Attention": Herbert Woodrow (Ph.D., 1909), associate professor of psychology, University of Minnesota.

"The Relation of Recall to Recognition Memory": Garry C. Myers (Ph.D., 1913), instructor in psychology, Brooklyn Training School for Teachers.

"Visual Rhythms:" Kate Gordon (Ph.D., Chicago, 1903), professor of educational psychology, Bryn Mawr College.

Tuesday, April 7, at 8 P.M.

"Some Applications of Psychological Tests to the Determination of Industrial and Professional Fitness": B. B. Breese (Ph.D., 1899), professor of psychology, University of Cincinnati.

"Individual Psychology and the Problem of Vocational Guidance": F. G. Bonser (Ph.D., 1910), associate professor and director of industrial arts, Teachers College, Columbia University.

"The Reliability of Judgments of Mental Ability, with Applications to the Selection of Persons for Positions": B. R. Simpson (Ph.D., 1912), instructor in psychology, Brooklyn Training School for Teachers.

"Relation of Earning Power to School Performance": D. Edgar Rice (Ph.D., 1912), secretary, Pratt Institute.

"An Empirical Study in Valuation": E. K. Strong, Jr. (Ph.D., 1911), fellow in advertising, Columbia University, appointed professor of psychology, George Peabody College for Teachers.

"An Empirical Study in Valuation:" E. N. Henderson (Ph.D., 1903), professor of education, Adelphi College.

Wednesday, April 8, at 3 P.M.

"Traits of the Psychoses from the Standpoint of Individual Differences": F. Lyman Wells (Ph.D., 1906), psychologist at McLean Hospital; lecturer on pathological Psychology, Harvard University.

"Indications of a Connection between Accidents, Divorce, Alcoholism, Illegitimate Birth and Mental Defect": Siegfried Block, M.D. (M.A., 1910), Medical Examiner, Children's Court, Brooklyn.

"Further Studies of the Only or Favorite Child in Adult Life": A. A. Brill (M.D., 1903), chief of clinic, department of psychiatry, Columbia University.

"Individual Differences in Dreams": Lydiard H. Horton (M.A., 1911), interne in psychopathology, Boston State Hospital.

"Practical Aspects of Individual Differences in Practicability": H. L. Hollingworth (Ph.D., 1909), assistant professor of psychology, Barnard College, Columbia University.

"The Activity Attitude and Meumann's Individual Types of Will": Margaret Floy Washburn, Ph.D., professor of psychology, Vassar College.

Others whose names were on the printed program, but who were unfortunately unable to appear, were Professor Walter F. Dearborn, of Harvard University; Professor S. I. Franz, of George Washington University, and scientific director at the Government Hospital for the Insane, and Dr. Edwin Grant Dexter, director of the Canal Zone Museum at Panama.

R. S. Woodworth